PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 12 January 2001 (12.01.01)	
International application No. PCT/GB00/01999	**Applicant's or agent's file reference** P/61705/GPTU73
International filing date (day/month/year) 25 May 2000 (25.05.00)	**Priority date** (day/month/year) 27 May 1999 (27.05.99)
Applicant CHOPPING, Geoffrey et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

24 November 2000 (24.11.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Olivia TEFY

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREA

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
P/61705/GPTU73		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 01999	25/05/2000	27/05/1999
Applicant		
MARCONI COMMUNICATIONS LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 3

[ ] as suggested by the applicant.

[X] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/01999

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KUNIO KAMIMURA ET AL: "AN EFFICIENT METHOD FOR DETERMINING ECONOMICAL CONFIGURATIONS OF ELEMENTARY PACKET-SWITCHED NETWORKS" IEEE TRANSACTIONS ON COMMUNICATIONS,US,IEEE INC. NEW YORK, vol. 39, no. 2, 1 February 1991 (1991-02-01), pages 278-288, XP000225306 ISSN: 0090-6778 abstract page 278, right-hand column, line 13 - line 46; figure 1 page 279, right-hand column, line 1 - line 41; figure 2	1,2,4-6, 8,26,27
Y		7,17,18, 21,28
A		3,9,15, 16,22-25

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 September 2000	22/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Brichau, G

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	GERLA M ET AL: "PROTOCOLS FOR AN OPTICAL STAR INTERCONNECT FOR HIGH SPEED MESH NETWORKS" PROCEEDINGS OF INFOCOM,US,LOS ALAMITOS, IEEE COMP. SOC. PRESS, vol. CONF. 14, 2 April 1995 (1995-04-02), pages 146-153, XP000580574 ISBN: 0-7803-2524-9 page 146, left-hand column, line 1 -right-hand column, line 11; figure 1 page 148, left-hand column, line 28 -page 149, left-hand column, line 18; figure 3	17,18,21
A		20
Y	GB 2 258 582 A (PLESSEY TELECOMM) 10 February 1993 (1993-02-10) page 3, line 1 - line 15 page 10, line 1 -page 11, line 30 page 15, line 4 -page 16, line 35 page 21, line 26 -page 29, line 9	7,28

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/01999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2258582 A	10-02-1993	DE 69226013 D	30-07-1998
		DE 69226013 T	29-10-1998
		EP 0555429 A	18-08-1993
		ES 2117671 T	16-08-1998
		WO 9303565 A	18-02-1993
		JP 6501829 T	24-02-1994
		US 5703879 A	30-12-1997

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

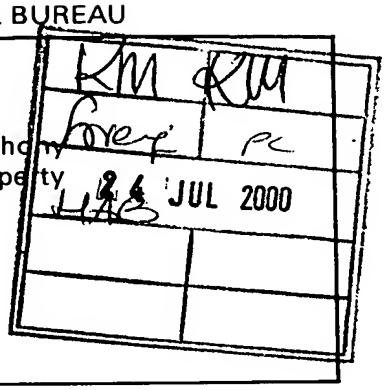
PCT

NOTIFICATION OF RECEIPT OF RECORD COPY

(PCT Rule 24.2(a))

To:

BRAMFIELD, Henry, Anthony
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI



Date of mailing (day/month/year)	IMPORTANT NOTIFICATION
11 July 2000 (11.07.00)	
Applicant's or agent's file reference	**International application No.**
P/61705/GPTU73	PCT/GB00/01999

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

MARCONI COMMUNICATIONS LIMITED (for all designated States except US)
CHOPPING, Geoffrey et al (for US)

International filing date	:	25 May 2000 (25.05.00)
Priority date(s) claimed	:	27 May 1999 (27.05.99)
Date of receipt of the record copy by the International Bureau	:	28 June 2000 (28.06.00)
List of designated Offices	:	

AP :GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZW
EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE
OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
National :AE,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,NO,NZ,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,US,UZ,VN,YU,ZA,ZW

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

[X] time limits for entry into the national phase

[X] confirmation of precautionary designations

[X] requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:

I. Britel

Telephone No. (41-22) 338.83.38

INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. **It is the applicant's responsibility** to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

PATENT COOPERATION TREATY

4

From the INTERNATIONAL BUREAU

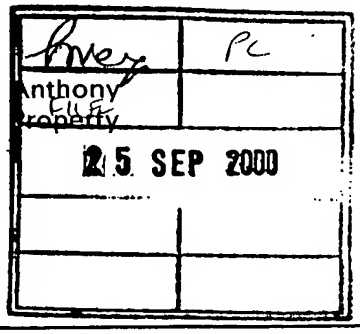
PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

BRAMFIELD, Henry, Anthony
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI



Date of mailing (day/month/year) 13 September 2000 (13.09.00)	
Applicant's or agent's file reference P/61705/GPTU73 - FWC WOP CWPIS	**IMPORTANT NOTIFICATION**
International application No. PCT/GB00/01999	International filing date (day/month/year) 25 May 2000 (25.05.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 27 May 1999 (27.05.99)
Applicant MARCONI COMMUNICATIONS LIMITED et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
27 May 1999 (27.05.99)	9912290.5	GB	24 Augu 2000 (24.08.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

I. Britel

Telephone No. (41-22) 338.83.38

WO 00/74320
PCT/GB00/01999

PATENT COOPERATION TREATY

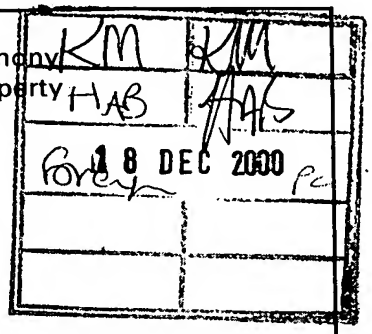
From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
BRANFIELD, Henry, Anthony
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI



Date of mailing (day/month/year) 07 December 2000 (07.12.00)	
Applicant's or agent's file reference P/61705/GPTU73	**IMPORTANT NOTICE**
International application No. PCT/GB00/01999	**International filing date** (day/month/year) 25 May 2000 (25.05.00)
Priority date (day/month/year) 27 May 1999 (27.05.99)	
Applicant MARCONI COMMUNICATIONS LIMITED et al	

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD,
   GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,
   NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   07 December 2000 (07.12.00) under No. WO 00/74320

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

KM. KM
forex
22 JAN

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

To:

BRANFIELD, Henry, Anthony
Marconi Intellectual Property
Waterhouse Lane
Chelmsford
Essex CM1 2QX
ROYAUME-UNI

INFORMATION CONCERNING ELECTED OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

Date of mailing (day/month/year) 12 January 2001 (12.01.01)	
Applicant's or agent's file reference P/61705/GPTU73	**IMPORTANT INFORMATION**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/GB00/01999	25 May 2000 (25.05.00)	27 May 1999 (27.05.99)

Applicant
MARCONI COMMUNICATIONS LIMITED et al

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

   AP :GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZW
   EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE
   National :AU,BG,CA,CN,CZ,DE,IL,JP,KP,KR,MN,NO,NZ,PL,RO,RU,SE,SK,US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

   EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
   OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
   National :AE,AL,AM,AT,AZ,BA,BB,BR,BY,CH,CR,CU,DK,DM,EE,ES,FI,GB,GD,GE,GH,
   GM,HR,HU,ID,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MW,MX,PT,SD,
   SG,SI,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing , if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

   Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

   The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:
Olivia TEFY

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
P/61705/GPTU73		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/01999	25/05/2000	27/05/1999
International Patent Classification (IPC) or national classification and IPC H04L12/56		
Applicant MARCONI COMMUNICATIONS LIMITED		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 1 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
24/11/2000	13.08.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Jimenez Hernandez, P Telephone No. +49 89 2399 7938

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01999

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-16,18-29	as originally filed			
17	as received on	23/06/2001	with letter of	19/06/2001

Claims, No.:

1-28	as originally filed

Drawings, sheets:

1/36-36/36	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-28
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-28
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-28
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The subject-matter of claim 1 meets the requirements of novelty and inventive step (Art. 33(1)-(3) PCT):

1.1 Claim 1 relates to a partially interconnected network topology comprising area nodes and star nodes, wherein each area node is connected to more than one star nodes.

D1 = GERLA M ET AL: 'PROTOCOLS FOR AN OPTICAL STAR INTERCONNECT FOR HIGH SPEED MESH NETWORKS' PROCEEDINGS OF INFOCOM,US,LOS ALAMITOS, IEEE COMP. SOC. PRESS, vol. CONF. 14, 2 April 1995 (1995-04-02), pages 146-153, XP000580574 ISBN: 0-7803-2524-9, which relates to the same field of networking, discloses a topology of the same type and is considered as the closest prior art.

D1 proposes also a partially interconnected network where, in the terminology of claim 1, several area nodes and a single star node are used (see Fig. 1).

1.2 Claim 1 is distinguished from **D1** in that several star nodes are used and each area node is interconnected to a set of some of these star nodes.

The objective problem starting from **D1** is to increase the flexibility and efficiency in the network design regarding switching fabric partitioning, line and equipment redundancy characteristics and capacity upgradeability of the network. The objective problem has been correctly assessed by the applicant in page 6, lines 14-23 of the description.

1.3 Neither **D1** nor **D2 = KUNIO KAMIMURA ET AL: 'AN EFFICIENT METHOD FOR DETERMINING ECONOMICAL CONFIGURATIONS OF ELEMENTARY PACKET-SWITCHED NETWORKS' IEEE TRANSACTIONS ON COMMUNICATIONS,US,IEEE INC. NEW YORK, vol. 39, no. 2, 1 February 1991 (1991-02-01), pages 278-288, XP000225306 ISSN: 0090-6778** or

D3 = GB-A-2 258 582 (PLESSEY TELECOMM) 10 February 1993 (1993-02-10) disclose or suggest the subject-matter of claim 1.

2. The dependent claims 2-27 further limit the independent claim 1 and likewise meet the requirements of Art. 33(2), (3) PCT.

3. The subject-matter of claim 28 meets the requirements of Art. 33(2), (3) PCT:

3.1 Claim 28 corresponds to claim 1 since it relates to a three-stage switching matrix where the stages are connected using the topology characterized by claim 1. Since said topology is not disclosed or suggested in the prior art, Claim 28 likewise meets the requirements of novelty and inventive step (Art. 33(1)-(3) PCT).

Re Item VII

Certain defects in the international application

1. The claims do not contain reference signs in parentheses, Rule 6.2(b) PCT.

2. **D1** should be mentioned in the description, Rule 5.1(a)(ii) PCT.

Re Item VIII

Certain observations on the international application

1. Certain terms in parentheses (eg. *(STARs), (CHOICE), (ROUTEs)*) contained in the claims are not reference signs in the meaning of Rule 6.2(b) PCT, nor do they belong to mathematical formulae. Therefore, these terms cause unclarity in the definition of the scope of protection (Art. 6 PCT). In order to overcome this problem, parentheses could have been substituted by commas in all expressions within parenthesis in claims 1, 2, 4, 23, 24 and 28 not belonging to mathematical formulae. These terms could alternatively have been introduced with "hereinafter referred to as", eg *,hereinafter referred to as STARs,* instead of *(STARs)* in Claim 1.

255	x	254	x	64	=	255	x	128	x	127
511	x	510	x	128	=	511	x	256	x	255

Figures 37 and 38 show an original single CHOICE pattern of 7 AREAs and 7 STARs (Figure 37) and its converse twin CHOICE pattern of 7 AREAs and 7 STARs (Figure 38). The converse pattern is formed by replacing each entry of a '1' with a null entry and replacing each null entry with a '1'. By taking one copy of one of these patterns and three copies of the other a larger pattern can be formed providing, that an appropriate extra column and row are added each time a larger pattern is formed in such a way.

In Figures 39 and 40 are shown 15 AREAs/15 STARs, 3 CHOICE and 4 CHOICE patterns respectively, formed from 3 Original 7x7 patterns and 1 Converse 7x7 pattern and 1 Original 7x7 pattern and 3 Converse 7x7 patterns, respectively.

In Figures 41 and 42 are shown 31 AREAs/31 STARs, 7 CHOICE and 8 CHOICE patterns respectively, formed from 3 Original 15x15 patterns and 1 Converse 15x15 pattern and 1 Original 15x15 pattern and 3 Converse 15x15 patterns, respectively.

The Rotational patterns for 31 AREAs/STARs and 63 AREAs/STARs patterns are known and hence the converses are also known. The larger patterns for 127 AREAs/STARs, 255 AREAs/STARs, 511 AREAs/STARs, etc can be constructed, in a similar manner shown.

The 64 kbit/s switch DSS (Digital Switching Subsystem) mk2 as used in System X and as described in patent GB2212364B, in particular figures 3 and 4 thereof as shown in Figures 43 and 44 respectively herein. GB 2212364B being imported herein for reference has:

256 first stage switching elements (256x384 channels)

Replaced by Article 34

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

BRANFIELD Henry Anthony
Marconi Intellectual Property
Waterhouse Lane
CHELMSFORD ESSEX CM1 2QX
GRANDE BRETAGNE

2 APR 2001

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	30.03.2001
Applicant's or agent's file reference P/61705/GPTU73	**REPLY DUE** **within 3 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/01999	25/05/2000	27/05/1999

International Patent Classification (IPC) or both national classification and IPC

H04L12/56

Applicant

MARCONI COMMUNICATIONS LIMITED

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☐	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis. For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 27/09/2001.

Name and mailing address of the international preliminary examining authority:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Jimenez Hernandez, P

Formalities officer (incl. extension of time limits)

Barrio Baranano, A
Telephone No. +49 89 2399 8621

I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed")*:

Description, pages:

1-29 as originally filed

Claims, No.:

1-28 as originally filed

Drawings, sheets:

1/36-36/36 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item VII
Certain defects in the international application

1. The claims should contain reference signs in parentheses, Rule 6.2(b) PCT.

2. Independent claim 1 should be in the two-part form vis-à-vis **D1 =GERLA M ET AL: 'PROTOCOLS FOR AN OPTICAL STAR INTERCONNECT FOR HIGH SPEED MESH NETWORKS' PROCEEDINGS OF INFOCOM,US,LOS ALAMITOS, IEEE COMP. SOC. PRESS, vol. CONF. 14, 2 April 1995 (1995-04-02), pages 146-153, XP000580574 ISBN: 0-7803-2524-9,** which is considered to be the closest prior art, Rule 6.3(b) PCT.

   D1 discloses the topology features corresponding to lines 1-5 of claim 1, whereby a single star node instead of a plurality of them is disclosed (page 146, left-hand column, last line - right-hand column, line 7 and Fig. 1).

3. **D1** should be mentioned in the description, Rule 5.1(a)(ii) PCT.

4. The phrase "GB 2212364B being imported herein for reference" on page 17, line 24 should be deleted as the application should be self-contained; such referenced documents are not regarded as part of the disclosure unless they contain matter essential to the invention, in which case the subject-matter in question would have to be incorporated into the description. This however is not the case here (see PCT International Preliminary Examination Guidelines II-4.17).

Re Item VIII
Certain observations on the international application

1. Parenthesis should be substituted by commas in all expressions within parenthesis in claims 1, 2, 4, 23, 24 and 28 not belonging to mathematical formulas, eg. Claim 1, *(STARs), (CHOICE)* (Art. 6 PCT).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 December 2000 (07.12.2000)

PCT

(10) International Publication Number
WO 00/74320 A1

(51) International Patent Classification[7]: H04L 12/56

(21) International Application Number: PCT/GB00/01999

(22) International Filing Date: 25 May 2000 (25.05.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9912290.5 27 May 1999 (27.05.1999) GB

(71) Applicant *(for all designated States except US)*: **MARCONI COMMUNICATIONS LIMITED** [GB/GB]; New Century Park, P.O. Box 53, Coventry CV3 1HJ (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **CHOPPING, Geoffrey** [GB/GB]; Tregarth, Furze Hill, Wimborne, Dorset BH21 4HD (GB). **MADDERN, Thomas, Slade** [GB/GB]; 38 Cutlers Place, Cole Hill, Wimborne, Dorset BH21 2HU (GB). **JENSEN, Bruce, Philip** [US/GB]; 13 Poole Road, Wimborne, Dorset BH21 1QA (GB).

(74) Agent: **BRANFIELD, Henry, Anthony**; Marconi Intellectual Property, Waterhouse Lane, Chelmsford, Essex CM1 2QX (GB).

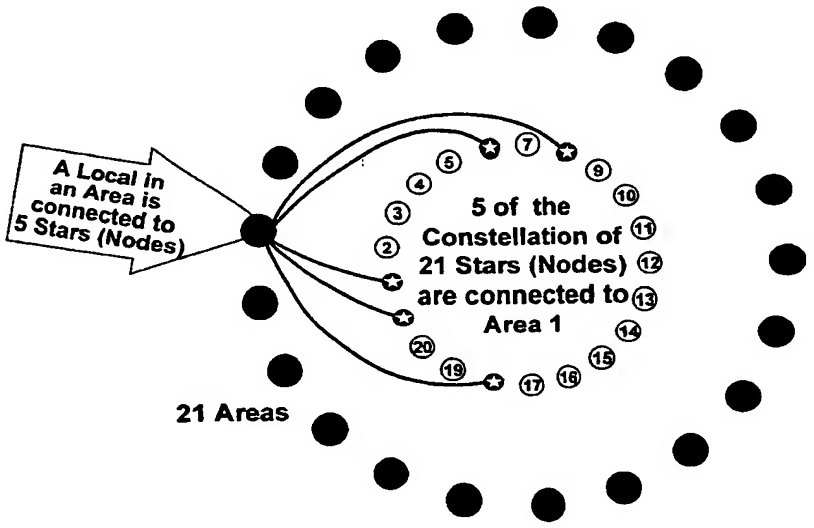
(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

[Continued on next page]

(54) Title: NETWORK INTERCONNECTIONS



(57) Abstract: A partially interconnected networks has a plurality of Allocated Nodes, which Allocated Nodes are each allocated to one of a number of AREAs, and further has a plurality of Star Nodes (STARs), and also has point to point interconnections between the Allocated Nodes and the Star Nodes, where the number of AREAs with Allocated Nodes connected to an individual STAR forms the number of ROUTEs from an individual STAR, the Allocated Nodes of a first of the AREAs being connected to a set comprising some, but not all, of the Star Nodes, and further of the AREAs are similarly interconnected to further sets each comprising Star Nodes and there is at least one connection choice between any two Allocated Nodes in different AREAs and where a connection route is two point-to-point interconnections connected in series by a Star Node.

WO 00/74320 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

NETWORK INTERCONNECTIONS

The interconnection of nodes within a network can be limited by a number of physical aspects. which can totally prevent some topologies. or make other topologies comparatively inefficient. Multistage networks are a way of building large networks from nodes of limited capability, but restricting the number of stages traversed to a minimum is a very desirable goal.

It is desirable in practical multistage networks, particularly where the nodes are on different geographical sites, to restrict the total number of interconnection routes to any node.

Fully-interconnected 3-stage networks have a large CHOICE of ROUTEs which can cause considerable searching difficulties. A fully-interconnected network is shown in Figure 1, where 7 Area Nodes are fully connected via 7 STAR Nodes. Partially Interconnected Networks which have a smaller, but fixed, choice in the number of routes between all the nodes that wish to be interconnected, are of considerable benefit for the implementation of practically dimensioned networks.

According to the present invention there is provided a partially interconnected network comprising a plurality of Allocated Nodes, which Allocated Nodes are each allocated to one of a number of AREAS. and further comprising a plurality of STAR Nodes (STARs), and also comprising point to point interconnections between the Allocated Nodes and the STAR Nodes. where the number of AREAs with Allocated Nodes connected to an individual STAR forms the number of ROUTEs from an individual STAR, the Allocated Nodes of a first of the AREAs being connected to a set comprising some. but not all, of the STAR Nodes. and wherein further of the AREAs are similarly connected to further sets each comprising STAR Nodes and where

there is at least one connection choice (CHOICE) between any two Allocated Nodes in different AREAs and where a connection route comprises two point to point interconnections connected in series by a STAR Node.

The present invention will now be described by way of example, with reference to the accompanying drawings, in which,

Figure 1 shows a schematic diagram of a fully-interconnected network;

Figure 2 shows a schematic diagram of a fully-meshed network;

Figure 3 shows a schematic diagram where one AREA is connected to 5 STARs;

Figure 4 shows a schematic diagram where STARs are each connected to 5 AREAs;

Figure 5 shows the connections in the diagram of Figure 4 in tabular form;

Figure 6 shows the contiguous sequences from Figure 4;

Figure 7 shows the connections of a counter rotational version of Figure 5 in tabular form;

Figure 8 shows the example of Figure 5 where the AREAs and STARs have been reordered;

Figure 9 shows a schematic diagram using a single SDH-AREA Crosscomect;

Figure 10 shows a schematic diagram using a pair of SDH-AREA Crossconnect;

Figure 11 lists examples of Rotational Patterns;

Figure 12 lists examples of Other Patterns;

Figure 13 shows an example of a twin choice pattern;

Figure 14 shows an example of a triple choice pattern;

Figure 15 shows an example of a quad choice pattern;

Figure 16 shows an example of a quin choice pattern;

Figure 17 shows a network using SDH interfaces on DSS mk2;

Figure 18 shows an example of a Multi-Rotational Pattern;

Figure 19 shows an Asymmetric Twin CHOICE network;

Figure 20 shows a Symmetrical Twin CHOICE Pattern ;

Figure 21 shows a re-ordered example of a Symmetrical Twin CHOICE Pattern:

Figure 22 shows an Equally Grouped Asymmetric single CHOICE Pattern

Figure 23 shows an Unequally Grouped Asymmetric single CHOICE Pattern:

Figure 24 shows an Asymmetric Twin CHOICE network for 10 AREAs;

Figure 25 shows an Asymmetric Triple CHOICE network for 8 AREAS;

Figure 26 shows an Asymmetric Twin CHOICE network

Figure 27 shows a Single CHOICE Asymmetric Pattern using 3-pointed STARs;

Figure 28 shows a Single CHOICE Asymmetric Pattern based on an odd square:

Figure 29 shows a 30 AREA Single CHOICE network using 5-pointed STARs;

Figure 30 shows a 56 AREA Single CHOICE network using 7-pointed STARs

Figure 31 shows a 15 AREA Single CHOICE network using 3-pointed STARs;

Figure 32 shows a 21 AREA Single CHOICE network using 3-pointed STARs:

Figure 33 shows a 27 AREA Single CHOICE network using 3-pointed STARs :

Figure 34 shows a Patially Interconnected Network having 11 AREAs and 11 off 5-pointed STARs:

Figure 35 shows a WAVESTAR for use in the mesh network of Figure 34;

Figure 36 shows the WAVESTAR connections to AREA 9 in Figure 34;

Figures 37 and 38 show a form of the original single choice 7 AREAs and 7 STARs pattern and its twin CHOICE converse which can be used to construct larger patterns:

Figures 39, 40, 41 and 42 show examples of patterns formed using smaller original and converse patterns:

Figures 43 and 44 show a Digital Switching Subsystem (DSS);

Figures 45A and 45B show a DMR transfer function:

Figure 46 shows an interconnection pattern for 20 NODEs:

Figure 47 shows the detail of AREA 4 of Figure 46;

Figure 48 shows a pattern using Perfect and Imperfect Constellations;

Figure 49 shows a pattern illustrating the application of 7 Mesh STARs;

Figure 49A shows the detail of a Mesh STAR from Figure 49; and

Figure 50 shows an example where there are multiple Partially Interconnected Networks with Mesh Connections between corresponding STARs.

Figure 1 gives an example of a fully-connected 3 Stage Network where 7 AREAs (Nodes) are fully interconnected via 7 STARs Nodes giving 7 routes between each pair of AREAs (Nodes), whereas Figure 2 shows a fully meshed network. The disadvantage of a fully meshed network is that as the number of AREA Nodes increases so the size of the routes between the AREA Nodes has to be reduced, if the switches at the AREA Nodes are already at maximum capacity.

In order to utilise regular interconnect patterns in networks with a variable number of local nodes (e.g. local exchanges), it is necessary to group the local nodes into areas. AREAs are not intended, in general, to represent geographical areas, though they may do so.

A number of regular interconnection patterns will now be shown where the number of STAR nodes (e.g. trunk exchanges) equals the number of AREAs (or an integral multiple of the number of AREAS). Further interconnection patterns will be shown where the number of STAR nodes does not equal the number of AREAs (or an integral multiple of the number of AREAS).

It is stressed that the number of circuits (or capacity) handled by a route will depend on the physical capacity of the transmission. The key aspect of the present invention is which nodes

have routes between them. the capacity of each route being a separate dimensioning issue and in practical networks the routes may not all have the same capacity/number of circuits.

A simple 3-stage network could have all the local nodes connected to all the STAR (Trunk) Nodes. For a Partially Interconnected Network: all the Local Nodes in an area are connected to a fixed number of STAR Nodes. but not to all the STAR Nodes.

Partially Interconnected Networks will have a fixed choice in the number of connection routes between a local node in one area and a local node in another area. This fixed number will be called CHOICE. as where there is more than one connection route a choice can be made between them. Where the CHOICE is one this is described as a Single Connectivity Pattern,where the CHOICE is two a Twin connectivity Pattern. etc.

For the purpose of understanding the patterns described it is easier to concentrate on the relationships between the AREAs and the STARs

One object of the present invention is to determine regular Partial Interconnection Networks with Single. Twin. etc. connectivity patterns. For there to be a possibility of this to happen the following relationship needs to be valid:

(AREAs) x (AREAs - 1) x (CHOICES) = (STARS) x (ROUTEs) x (ROUTES - 1) where

AREAs is the number of AREAs. CHOICEs is the fixed number of connection routes. STARS is the number of STAR Nodes. ROUTEs is the number of AREAS to which a STAR has connections.

This formula is only valid for integer values of AREAs, CHOICEs, STARs and ROUTEs. The object of the formula is to match the total number of single routes between the areas (AREAs) x (AREAs - 1) with the number of routes provided by each STAR Node, (ROUTEs) x (ROUTEs - 1) multiplied by the number of STARs. For multiple choice arrangements the STARs must provide 2, 3, etc. times the number of routes.

Just because there is a possibility of finding a fixed choice connectivity pattern does not mean that any such pattern exists. The following relationship also needs to be valid:

(STARs)x(ROUT'Es)/(AREAs) = a positive integer

This further relationship is of importance when the number of STARs is not equal to the Number of AREAs.

The benefits from using Partially Interconnected Networks (rather than not using) include:

building larger networks with the same size switch;

building the same network with less switches;

building larger networks from switches with limited numbers of ports;

reducing the number of switches that are traversed;

having multiple CHOICE routing;

having fault tolerant characteristics with "1 in N" sparing;

having effective growth characteristics;

having simple self-balancing traffic characteristics;

having larger route sizes as number of STARs increases;

being independent of switching technology.

Two important points to be remembered are. firstly that the network routing pattern can be expressed as a simple table (especially ones based on rotational patterns) and secondly that once the routing pattern is defined . the actual capacity of the individual connections and paths do not have to be the same size. In the PSTN for example a connection is normally made up from multiple primary rate multiplexes and this can still continue.

The segregation of Outer Nodes into AREAs should not necessarily be done so that there are the same number of Outer Nodes per AREA. but that the total traffic generated by an AREA should preferably not be widely dissimilar from the other AREAs.

Most traffic between Outer Nodes associated with the same AREA can be routed via a nearby STAR, although any of the STARs connected to that AREA can be used as alternatives.

There is a possible disadvantage with being connected to a STAR on the same site as the AREA Crossconnect. The two alternate routings between two adjacent AREAs may be carried by the same transmission system. There are patterns which ensure the alternative routings do not go along the same notional link. but these tend to require that an AREA N is not connected to a STAR N.

In the arrangements shown below the AREAs and STAR Nodes are cyclically numbered for ease of explanation. but this identification is not an essential feature of the invention and other identifiers may be used or none at all.

Consider 21 AREAs and 21 STARs as shown in Figures 3. 4 and 5:

AREA 1 is connected to STARs 1. 6. 8. 18. 21.

AREA 2 is connected to STARs 2. 7. 9. 19. 1.

AREA 3 is connected to STARs 3. 8. 10. 20. 2 etc.

To traverse from AREA 1 to AREA 2 there is only one route and that is via STAR 1

To traverse to other areas

1 to 3 via STAR 8	1 to 4 via STAR 21	1 to 5 via STAR 1
1 to 6 via STAR 6	1 to 7 via STAR 6	1 to 8 via STAR 8
1 to 9 via STAR 8	1 to 10 via STAR 6	1 to 11 via STAR 18
1 to 12 via STAR 8	1 to 13 via STAR 18	1 to 14 via STAR 21
1 to 15 via STAR 1	1 to 16 via STAR 21	1 to 17 via STAR 1
1 to 15 via STAR1	1 to 16 via STAR21	1 to 17 via STAR1
1 to 18 via STAR 18	1 to 19 via STAR 18	1 to 20 Via STAR 6
1 to 21 via STAR 21		

For the pattern shown in Figure 4 to have the single connectivity property listed above, the connections to a STAR from an AREA must have the property of a set forming a contiguous sequence. This is where all the modulo differences of the numbers allocated to the cyclically numbered STAR Nodes (connected to an AREA) selected in pairs form a contiguous sequence from one to the number of cyclically numbered AREAS less one.

For this example which uses 21 AREAS with connections to 5 STARs (namely 1, 6, 8, 18 and 21) out of a Constellation of 21 STARs (Figure 6) there are 10 pairings of STARs and the modulo differences are as follows:

STAR Pairings	Modulo Differences		
	SPANNING DIFFERENCES		
1 21	1	&	20
6 8	2	&	19
18 21	3	&	18
1 18	4	&	17

1	6	5	&	16
6	21	6	&	15
1	8	7	&	14
8	21	8	&	13
6	18	9	&	12
8	18	10	&	11

For each such fixed choice rotational connectivity pattern there is a similar, but counter-rotational version of the pattern of Figure 5, which is shown in Figure 7.

An arrangement of STARs (e.g. 21 STARS) is called a Constellation. For a network that requires twice the throughput then a second constellation could be connected in parallel to the first constellation. In such a case by using a fixed choice counter rotational connectivity pattern, then a significant advantage results. This not only adds redundancy, but also if a STAR should fail then the traffic formerly carried by the failed STAR could be shared between 4 STARs in the other 21 STAR Constellation.

The use of regular rotational patterns which provide contiguous sequences is a convenient way to analyse and deduce Partially Interconnected Networks which have a fixed choice connectivity for example single connectivity, twin connectivity, etc. However, once the connectivity pattern has been established the pattern can be transformed by reordering the AREAs and by reordering the STAR Nodes, whilst still retaining an equal number of connection routes between any two Local nodes in different areas. A connection route comprises two point-to-point interconnection means connected in series by a STAR Node, see Figure 8. The AREAs and STAR Nodes can

also be renumbered. The original AREA and STAR numbering used on Figure 5 is shown on the bottom and right respectively on Figure 8.

The use of Partially Interconnected Networks is appropriate to telecommunications networks which have local exchanges and trunk exchanges. The local exchanges are grouped into areas and connected to a set of STAR Trunks. In order to simplify transmission connections the use of an AREA Crosscomect can be considered. A Synchronous Digital Hierarchy (SDH) Crossconnect, or a pair of SDH Crossconnects for redundancy. Figures 9 and 10 respectively, can be employed. Two Synchronous Transport Module (STM)-1s are connected to a local, a pair of locals or 3 locals one being taken to each of the two Crossconnects making an AREA Crossconnect. A first set of STM- 1s is taken to the STAR Trunks (normally one per star) from a Replica A. A second set of STM- 1s is taken to the STAR Trunks (normally one per STAR) from Replica B.

The use of Partially Interconnected Networks is also appropriate to packet, router, transmission and indeed any large network where the sizes of switches are limited, or where redundant architectures are required.

In data networks running with the Internet Protocol (IP) the AREA Crossconnect could be an IP router, or a pair of IP routers for redundancy, or an ATM switch, or a pair of ATM switches for redundancy.

Figure 11 lists some examples of the rotational patterns where the number of STARs equals the number of AREAs or a multiple of the number of AREAs. The pattern examples detail the

AREAs connected to STAR 1 for rotational and multi-rotational patterns. Figure 12 lists some examples of non- rotational patterns.

Figure 11 and Figure 12 also list patterns that can be formed by taking a known CONSTELLATION using 7-pointed STARs and replacing all (or some) of the 7-pointed STARs with 7 three- pointed STARS. They also lists patterns that can be formed by taking a known constellation using 4-pointed STARs and replacing all (or some) of the 4-pointed STARs with 4 three- pointed STARs, the final pattern having twice the number of CHOICES. Similarly 7-pointed STARs can be replaced by 7 four-pointed STARS. Such transforms considerably increase the traffic carrying capacity of a network.

Another way of increasing capacity is by adding another complete constellation, however if only one or some STARs are overloaded then by just placing a further STAR in parallel with an existing STAR this will also increase the capacity of the overloaded part of the network. Although the network may have extra choices on some routes, this is still a very practical network. It is possible to limit the choices in the routing tables to restrict the choices whilst still retaining the increased load capacity.

Examples of Twin (Figure 13), Triple (Figure 14), Quad (Figure 15) and Quin (Figure 16) choice rotational connectivity patterns are shown on the indicated figures. The use of computer programs to look for valid contiguous spanning sequences can simplify the examination process.

Digital Switching Subsystem (DSS) mark 2 terminates STM-1 or part STM-1 as shown in Figure 17. DSS mark 2 is a subsystem of System X, which is a telecommunication system marketed by Marconi Communications Limited. G.703 is a telecommunication interface

recommendation by the International Telecommunications Union Telecommunications (ITU-T). The line shelf used can also terminate STM-4s. A STAR Trunk receives 6 x STM-1s from the 5 AREAS. DSS mark 2 can accept 30 or 31 STM- 1 s. The description is based on dedicated STM-1 transmission but Plesiochronous Digital Hierarchy (PDH) and STM-4s can be used where appropriate and all transport could also be patched through the general 2 Mbit/s network.

It is possible to have Partially Interconnected Networks where the number of STARs is not an integer multiple of the number of AREAS. Figure 18 shows an example of this where two different rotational arrangements are used to create a 3 CHOICE pattern. Other examples are listed in figure 11 for using 2, 3, 4 and 5 rotational arrangements to create both single and twin choice patterns.

It is also possible to have Partially Interconnected Networks where the number of STARs is not an integer multiple of the number of STARS, although (STARs) x (ROUTEs)/(AREAs) must be an integer. Figure 19 shows an Asymmetric twin choice network for 12 AREAs with 44 STARs which has 4 different patterns of 11 stars which rotate around 11 of the 12 AREAs and in which a large number of 3-pointed STARs are used.

Figure 20 has 16 AREAs and 16 STARs, but it is not formed from a single rotational pattern, but from 4 patterns. It is a twin CHOICE network giving redundancy with each numbered STAR being connected to the same numbered AREA. Because of its symmetry it only requires a total of 40 transmission links between the 16 AREA Nodes /(Crossconnects/Routers and the 16 STAR Nodes. However some care would be required as both paths of some redundant pairs of paths are carried by the same transmission link.

Figure 21 is a redrawn form of Figure 20, but without each numbered STAR being connected to the same numbered AREA. 48 transmission links are required between the 16 AREA Nodes /Crossconnects/Routers and the 16 STAR Nodes, but this time no redundant pairs of paths are carried by the same transmission link.

Figures 22 and 23 are two ways, using different groupings, that single connectivity networks can be formed for 16 AREAs and 20 STARs. These are examples of where the number of AREAs is neither equal to the number of STARs nor an integer multiple of the number of STARS. The figures are drawn with each numbered AREA being connected to the same numbered STAR.

Figure 24 uses 4-pointed STARs, but with'3 groups of 3 and 1 group of 1 to give a twin choice network for 10 AREAs using 15 STARs.

Figure 25 shows an Asymmetric Triple CHOICE network where the AREAs have been divided into two groups of 4 and 4-pointed STARs are used.

Figure 26 shows an Asymmetric Twin CHOICE network which has been drawn with each numbered STAR being connected to the same numbered AREA. Some of the following patterns are not drawn this way where it is easier to show how a range of patterns can be constructed from a basic concept.

Figures 27 and 28 both have 9 AREAs and 12 STARs, but the two figures have been drawn in slightly different ways.

Figure 28 is the first of an infinite series of patterns: where the STARs have an odd number of ROUTEs {ROUTEs equals an odd integer}: where the number of AREAs is the square of the number of ROUTEs on the STAR i.e. {AREAs = (ROUTEs) x (ROUTEs-1)}: and where the number of STARs = (ROUTEs) x (ROUTEs+1). In this case ROUTEs = 3, AREAs = 9, STARs = 12.

Figure 29 shows the second in the series where ROUTEs = 5, AREAs = 25, STARs = 30.

Figure 30 shows the third in the series where ROUTEs = 7, AREAs = 49, STARs = 56.

Some more in this series are listed in Figure 12.

Figure 27 is the first of an infinite series of patterns using 3-pointed STARs where there are an odd number of groups and each group contains 3 AREAs.

Figure 31 is the second of the series with 35 off 3-pointed STARs connecting 15 AREAs. It shows the same pattern in three ways in order to help explain the notation used in later figures. The extra numbers to the right of the first pattern show the numbering of the STARs that would be necessary so that AREAs can be connected to a STAR with their own number.

Figure 32 is the third of the series with 70 off 3-pointed STARs connecting 21 AREAs. The first seven STARs are used to connect the AREAs together within a group with the remaining STARs used to connect 3 STARs from 7 of the groups.

Figure 33 is the fourth of the series with 117 off 3 -pointed STARs connecting 21 AREAs. The first seven STARs are used to connect the AREAs together within a group with the remaining STARs used to connect 3 STARs from 9 of the groups. Figure 33 has been drawn showing how

9 STARs use the same pattern that has been shifted round by one. There are 12 such shifted patterns. The same form of pattern is used in each of the columns. In the first column the spacing of the '1's is increased by one between each arrangement of 9 STARs whilst the '2' is always equidistant from each of the '1's.

A Partially Interconnected Network may be created where the STARs are WAVESTARs, that is the links are optical links.

Considering a network as shown in Figure 34 where a full mesh is required between all the 11 AREAs , A=11. Consequently A(A-1) direct simplex links, in this case 110, would be required. Yet this would result in only a single CHOICE network and there would be no redundancy. The full mesh required is achieved, in Figure 34, by using 11 WAVESTARs, each with 5 ROUTEs. Each AREA is connected to 5 WAVESTARs and each WAVESTAR is connected to 5 AREAs.

A detailed arrangement of each of the WAVESTARs is shown in Figure 35. Such a WAVESTAR uses Wavelength Division Multiplexes of four wavelengths.
Further detail is shown in Figure 36, where AREA 9 is shown having duplex WDM connections to WAVESTARs 3, 6, 8, 9 and 10.

If WAVESTARs are considered only as a special form of repeater then there are only 55 simplex connections for this redundant twin CHOICE Partially Interconnected Network, compared with the 110 simplex connections for the unsecured single CHOICE mesh network.

Each WAVESTAR can be a passive optical device, probably with an optical amplifier on each input and output. The loss of an amplifier would not lead to the whole WAVESTAR being removed from service.

Using WAVESTARs enables diverse redundant mesh network topologies to be constructed from a reduced number of high bandwidth WDM links

For networks it may often be adequate to have just 2 or 3 CHOICEs of routing. However, for a large three-stage switch which is made up from switching elements and which has multiple first stage switching elements, multiple second stage switching elements and multiple third stage switching elements, then if a Partially Interconnected Network is used to join the said first stages to the said second stages and is also used to connect the said second stages to the said third stages, then networks having a large number of CHOICES seem to be much more appropriate. Some very useful arrangements are achieved when:

CHOICEs = a binary power of 2

(CHOICEs) x2 = ROUTEs

(ROUTEs) x2 = AREAs + 1

(ROUTEs) x2 = STARs + 1

and AREAs x (AREAs -1) x CHOICEs = STARs x ROUTEs x (ROUTEs -1)

7	x	4	x	2	=	7	x	4	x	3
15	x	14	x	4	=	15	x	8	x	7
31	x	30	x	8	=	31	x	16	x	15
63	x	62	x	16	=	63	x	32	x	31
127	x	126	x	32	=	127	x	64	x	63

255	x	254	x	64	=	255	x	128	x	127
511	x	510	x	128	=	511	x	256	x	255

Figures 37 and 38 show an original single CHOICE pattern of 7 AREAs and 7 STARs (Figure 37) and its converse twin CHOICE pattern of 7 AREAs and 7 STARs (Figure 38). The converse pattern is formed by replacing each entry of a '1' with a null entry and replacing each null entry with a '1'. By taking one copy of one of these patterns and three copies of the other a larger pattern can be formed providing, that an appropriate extra column and row are added each time a larger pattern is formed in such a way.

In Figures 39 and 40 are shown 15 AREAs/15 STARs, 3 CHOICE and 4 CHOICE patterns respectively, formed from 3 Original 7x7 patterns and 1 Converse 7x7 pattern and 1 Original 7x7 pattern and 3 Converse 7x7 patterns, respectively.

In Figures 41 and 42 are shown 31 AREAs/31 STARs, 7 CHOICE and 8 CHOICE patterns respectively, formed from 3 Original 15x15 patterns and 1 Converse 15x15 pattern and 1 Original 15x15 pattern and 3 Converse 15x15 patterns, respectively.

The Rotational patterns for 31 AREAs/STARs and 63 AREAs/STARs patterns are known and hence the converses are also known. The larger patterns for 127 AREAs/STARs, 255 AREAs/STARs, 511 AREAs/STARs, etc can be constructed, in a similar manner shown.

The 64 kbit/s switch DSS (Digital Switching Subsystem) mk2 as used in System X and as described in patent GB2212364B, in particular figures 3 and 4 thereof as shown in Figures 43 and 44 respectively herein. GB 2212364B being imported herein for reference has:

256 first stage switching elements (256x384 channels)

384 second stage switching elements (256x256 channels)

256 third stage switching elements (384x256 channels)

where the unsquare switching elements are each formed form two 256x256 channel switching Integrated circuits. System X is a Stored Program Control exchange system first installed in the United Kingdom.

This telecommunications switch has a partial CLOS expansion of 256 to 384 second stage switching elements. so although DSS Mk2 is not a fully non-blocking switch it has an extremely low blocking probability. Thus DSS mk2 handles 2048 PCMs of 2 Mbit/s and switches a total of 65,536 channels of 64 kbit/s. By using the largest of the pattern listed above. namely 511 AREAs, 511 STARs, 256 ROUTEs and 128 CHOICEs. a switch of 4080 Pulse Code Modulation (PCMs) of 2 Mbit/s. handling 130,560 channels can be constructed with a similar blocking probability to the original DSS mk2 as used in System X. This new switch could be formed from:

511 first stage switching elements (256x512 channels)

1022 second stage switching elements (256x256 channels)

511 third stage switching elements (512x256 channels)

where the unsquare switching elements are each formed from two 256x256 channel switching Integrated circuits.

The 511 first stage switching elements (using 256 of the outputs of each switching element) are connected to 511 of the second stage switching elements which in turn are connected to the 511 third stage switching elements (using 256 of the inputs of each switching element) by employing the connection pattern mentioned above.

An identical connection pattern is used to connect the other 256 outputs of the first stage switching elements to the other 511 second stage switching elements which in turn are connected to the remaining 256 inputs of the third stage switching elements.

However as the switching elements already have 8 outputs. a more practical implementation would be to use 8 Partially Interconnected Networks in parallel. Consequently by using the pattern with 63 AREAs. 63 STARs. 32 ROUTEs and 16 CHOICEs as shown in Figure 46, a switch of 4032 PCMs of 2 Mbit/s. handling 129.024 channels can be constructed with a similar blocking probability to the original DSS mk2 as used in System X. This new switch could be formed from:

504 first stage switching elements	(256x512 channels)
1008 second stage switching elements	(256x256 channels)
504 third stage switching elements	(512x256 channels)

where the unsquare switching elements are each formed form two 256x256 channel switching Integrated circuits.

With reference to figure 4 of the said patent (Figure 44 herewith). the 32x32 Demultiplexing/Mixing/Remultiplexing (DMR) devices would become 63x63 DMR devices. but still only having a 32 timeslot loop. The other changes to the diagram would be:

8x16 DSMs in first stage

0-503 first stage PLANEs

0-4031 PCM lines into first stage

0-15 SUPER PLANES each with 0-62 DSMs

16x8 DSMs in third stage

0-503 third stage PLANEs

0-4031 PCM lines out from third stage

The transfer function of the resulting DMR is shown in Figures 45A and 45B which are combined horizontally.

There are many ways that Partially Interconnected Networks can be deployed.

One of the most important aspects of large networks is their need to grow (or contract) over a period of time.

The first example explains the concept of having many outer nodes in an AREA.

The second example uses a combination of a Perfect Pattern and an Imperfect Pattern to enable a network to be doubled in size.

The third example uses a Partially Interconnected topology, but uses a distributed mesh of switches to form each STAR.

The fourth example has several similar Partially Interconnected Networks where corresponding STARs in each network are connected together using a distributed mesh topology.

1: A BASIC EXAMPLE

Considering 20 nodes that need to be interconnected where it is deemed impractical to connect all the nodes into a mesh, or to connect all the 20 nodes to one or two central nodes (for example because of power or port limitations). It is also required normally that for redundancy there must

be at least two routings through the network. There is no perfectly regular twin CHOICE interconnection pattern with say 20 Outer Nodes and about 6 central nodes each with no more than 12 ports. In most networks the perception is that if there are a number of Outer Nodes then a lesser number of central nodes are required to join them together.

For example the average PSTN has more Local exchanges than Trunk Exchanges. However, if some compromises are made to the basic example then a practical solution is available. Figure 46, which is based on the twin CHOICE network of Figure 13 which shows an arrangement where there are actually 21 Outer Nodes and 7 STARs (Central Nodes). An Outer Node can be omitted to meet the requirement of 20.

It may seem to be a five stage network:

Outer Node - AREA - STAR - AREA - Outer Node:

but the AREAs can purely be patch panels, or a fixed setting on a cross-connect, because an AREA does not have to be an active Switching Node.

Figure 47 shows in more detail the arrangements around the AREA 4. The connection from a STAR into an AREA can consist of 3 links which each go directly to associated Outer Nodes. As a STAR, in this example, is connected to 4 AREAs, the STAR has links to 12 of the Outer Nodes provided all AREAs have 3 Outer Nodes. However regardless of the number of Outer Nodes within an AREA, all the Outer Nodes are connected to 4 STARs.

Even if the example had specified 21 Outer Nodes and 7 STARs, there is still a compromise in this network. An Outer Node should have just have a CHOICE of two routings to each of the other Outer Nodes. Outer Nodes connected to Outer Nodes in other AREAs have 2 routings, but Outer Nodes have 4 CHOICEs of routing to each of the other 2 Outer Nodes belonging to their

own AREA. This is a direct consequence of having more than one Outer Node per AREA. However in many networks there is more traffic within an AREA than between AREAs.

Two points to be remembered are: firstly that the network routing pattern can be expressed as a simple table (especially where based on rotational patterns): and secondly that once the routing pattern has been defined the actual capacity of the individual connections and paths do not have to be the same size. In the PSTN for example a connection is normally made up from multiple primary rate multiplexes and this can still continue.

The segregation of Outer Nodes into AREAs should be done not necessarily so that there are the same number of Outer Nodes per AREA. but that the total traffic generated by an AREA should preferably not be widely dissimilar from the other AREAs.

A characteristic that can also be seen in Figure 46 is that each AREA has, adjacent to it, a STAR of the same number. This can mean that most traffic between Outer Nodes, associated with the same AREA, can be routed via a nearby STAR, although any of the STARs connected to that AREA can be used as alternatives.

There is a possible disadvantage with being connected to a STAR on the same site as the AREA Crossconnect. The two alternative routings between two Adjacent AREAs may be carried by the same transmission system. There are patterns which ensure the alternative routings do not go along the same notional link, but these tend to require that an AREA N is not connected to a STAR N.

PSTN

The basic example can be directly deployed by the PSTN.

A long distance path across a large PSTN normally results in the path passing through more than one Trunk Exchange. Partially Interconnected Networks are suited for 3-Stage networks. And so 3-stage structures must be created in order to take advantage of Partially Interconnected Networks for all types of Network.

In this basic example a 3-stage arrangement is achieved by making the Local Exchanges (Outer Nodes) the first and the third stages and having one level of Trunk Exchanges (STARs) to act as the second stage. In order to do this the Local Exchanges must have some network routing capability as multiple STAR Trunk Exchanges will be directly connected to each Local Exchange.

The basic example described used one of the standard Twin CHOICE patterns. Unfortunately the list of these is not very long. So choosing the initial pattern is restricted and growing by transforming to the next pattern will seldom if ever be ideal.

2: A COMBINATION OF PERFECT AND IMPERFECT PATTERNS EXAMPLE

As most large networks need redundancy either a Twin CHOICE network, or two Single CHOICE networks, will be required initially.

When the number of AREAs equals the number of STARs, then assuming a STAR can handle a certain amount of traffic, then each AREA should on average be organised to generate up to that amount of traffic. If there are twice the number of STARs to AREAs then an AREA should generate on average up to twice the capacity of a STAR.

To grow two Single CHOICE networks can be done by adding a third Single CHOICE network with the same number of AREAs and STARs as the first two. This gives a 50% increase in capacity.

Adding a Single CHOICE network to an existing Twin CHOICE network would be much better as firstly the self balancing of a twin CHOICE network is much better than that of two Single CHOICE Networks and secondly 100% growth could be achieved if the single and twin CHOICE networks have the same number of STARs. Unfortunately apart from 7 AREAs and 7 STARs networks which both have twin and single CHOICE Perfect patterns versions, none of the others do. However a large range of Imperfect patterns exist.

So if the 37 AREAs and 37 STARs Twin CHOICE network is used initially, then an Imperfect pattern with 37 AREAs and with 37 (or more) STARs can be added as required.

For the 37 AREAs and 37 STARs Twin CHOICE network, because the STARs are connected to 9 AREAs, the load balancing is very good, consequently under fault conditions if one STAR Trunk is unavailable its traffic is shared across all the other 36 STAR Trunks. This could be regarded as the ultimate automatic '1 in N sparing' Network.

Perhaps the ideal way to grow a Twin CHOICE Partially Interconnected Network would be to add individual STARs, of a Single CHOICE Constellation, as the average Network Load increases. The load balancing algorithm used needs to ensure that sufficient traffic is carried by the added STARs.

For a Twin CHOICE network with 37 AREAs and 37 STARs, it would be convenient if there was also a perfect Single CHOICE network with 37 AREAs and 37 STARs, because there cannot be a Perfect Partially Interconnected Network with STARs less than AREAs. Unfortunately there is no perfect pattern, with 37 AREAs and 37 STARs, but as has been mentioned earlier several patterns for 37 AREA networks have been listed.

There is a Multi-Rotational pattern with 37 AREAs which has 111 STARs each with 4 ROUTEs. However these STARs which have 4 ROUTEs only support paths between 6 AREAs, whereas STARs with 9 ROUTEs support 36 paths. So it seems sensible to try and use STARs with as many ROUTEs as possible.

The following Imperfect patterns with 37 AREAs have already been described::

- A Single CHOICE pattern with 54 STARs: 1 STAR of 7 ROUTEs: 23 STARs of 6 ROUTEs: and 30 STARs of 5 ROUTEs:

- A Single CHOICE pattern with some extra paths with 37 STARs all of 7 ROUTEs:

Either of the above could be used to expand the capacity, but the last one having STARs with 7 ROUTEs will probably give the most flexible network. This is shown in Figure 48.

There are also some other options which may be of use in certain circumstances:

a) adding a smaller constellation onto some of the AREAs:

b) adding a smaller constellation onto larger AREAs:

c) adding a STAR in parallel with each overloaded STAR:

Because of the self balancing nature of a twin CHOICE 37 AREAs and 37 STARs network, the incremental addition of individual STAR Trunks as traffic increases allows for increases of traffic to be fairly easily catered for. The addition of 37 more STARs should allow for the load to double.

Another example of a combination of a Perfect and an Imperfect Pattern could be with an Imperfect Twin CHOICE pattern of 57 AREAs and 57 STARs and a Perfect Single CHOICE 57 AREAs and 57 STARs.

Figure 48 is suitable for a large PSTN. The secured AREA function could be a pair of SDH crossconnects and most of the links could be one (or more) STM-1 equivalents. It uses the Trunk exchanges very effectively as only one needs to be traversed for any connection. Although the crossconnect makes the transmission much more straight forward than for an equivalent mesh network, the number of ROUTEs that have to be supported by the local exchanges is quite large.

3: A SINGLE PARTIALLY INTERCONNECTED NETWORK EXAMPLE

WITH A DISTRIBUTED MESH OF SWITCHES TO FORM EACH STAR

For small Partially interconnected networks the outer switches of each AREAs (e.g. local exchanges) are only connected to a few STARs, just 4 in the case of Figure 46. However the outer switches are connected to a great many more STARs for large Partially Interconnected Networks such as 16 STARs in Figure 48. So although in is only necessary to go through one central switch, it may be considered unacceptable to have each outer switch connected to so many STARs.

Combinations of Partially Interconnected Networks and Mesh networks are possible as explained in this and the next example.

The mesh network as shown in Figure 2 has only 7 AREAs. Some mesh networks may ideally need to have as many as a hundred major switches or routers connected together in a mesh. As already mentioned this would not be the easiest of implementations.

Figure 49, which is derived from the twin CHOICE network of Figure 13, represents a network which contains 7 separate mesh networks (instead of 7 STARs). The Outer Nodes, as represented in AREA 2, are each connected to 4 of the mesh nodes. For simplicity each mesh is shown has having four switches in the main part of Figure 49. Hence with this arrangement, there are two paths available, via two different meshes, between an Outer Node in one AREA and an Outer Node in another AREA. (The circular symbols represent part of the transmission medium and need not be active switches.)

In this example the Outer Nodes of an AREA are connected to the same 4 switches in each of 4 Distributed Mesh STARs which will be referred to later.

For larger networks each STAR mesh can of course contain more switches than four. If a STAR mesh contained say 12 switches, (giving a total of 84 switches) then the Outer Nodes in an AREA could be connected to one of 3 switches in a mesh (they would still be connected to 4 STAR meshes). In which case the transmission used to connected the switches together in a STAR mesh could also be of the form of a Partially Interconnected Network, as shown in the insert (Figure 49A) of Figure 49, using 4 Transmission STAR Nodes A, B, C and D. This

corresponds to the first Twin CHOICE pattern in list 2. which has 4 AREAs. Each AREA containing a multiple set of switches.

It should be remembered that smaller meshes. need less ports and therefore each port can be of high bandwidth.

Larger networks can also be made by using larger Partially Interconnected networks and more STAR mesh networks: or in some cases a very large (STAR) Router instead of a STAR mesh. where the distributed nature of a STAR mesh is not required and the switches has sufficient ports.

A useful feature of this example is that the 7 meshes can be grown independently of each other.

4: MULTIPLE PARTIALLY INTERCONNECTED NETWORKS EXAMPLE

WITH MESH CORRECTIONS BETWEEN CORRESPONDING STARs

In the previous example it was noted that the Outer Nodes of an AREA are connected to the same 4 switches in each of 4 Distributed Mesh STARs. This results in a fully connected network of the type shown in Figure 1. This is a less efficient network structure as compared with this next example. Figure 49 shows a total of 28 switches. making the 7 STARs. It is only the connections within the same AREA. which traverse just one switch: and they are a seventh of the possible network connections.

It should not be assumed that connection destinations always are randomly spread across the network. However for the purposes of simple comparisons that has been assumed.

Figure 50 shows 4 Regional Partially Interconnected Networks, where connections within a region need only pass through one STAR. The total network has 28 switches again, but this time the fraction of connections traversing one switch is now a quarter.

Star Trunks when used to implement Partially Interconnected Networks enable far more effective trunk networks to be achieved than by the use of the present two-stage network as shown in Figure 2. Double and Triple Connectivity patterns are very appropriate to new operator networks. The technique can also be applied to Router networks and transmission (e.g. Megastream) networks.

From the foregoing it can be appreciated that the scope for arrangements conforming to the present invention is extremely large.

CLAIMS

1 A partially interconnected network comprising a plurality of Allocated Nodes, which Allocated Nodes are each allocated to one of a number of Areas (AREAs), and further comprising a plurality of Star Nodes (STARs), and also comprising point to point interconnections between the Allocated Nodes and the Star Nodes, where the number of AREAs with Allocated Nodes interconnected to an individual Star forms the number of Routes (ROUTEs) from an individual STAR, the Allocated Nodes of a first of the AREAs being interconnected to a set comprising some, but not all, of the STAR Nodes, and wherein further of the AREAs are similarly interconnected to further sets each comprising STAR Nodes and where there is at least one interconnection choice (CHOICE) between any two Allocated Nodes in different AREAs and where an interconnection route comprises two point to point interconnections interconnected in series by a STAR Node.

2. A partially interconnected network as claimed in Claim 1, wherein there are an equal number (CHOICEs) of interconnection ROUTEs between any two Allocated Nodes in different AREAs and an equal number of ROUTEs from each STAR.

3. A partially interconnected network as claimed in Claim 1 or 2, wherein :
(AREAs) x (AREAs-1) x (CHOICEs) = (STARs) x (ROUTEs) x (ROUTEs-1) and
(STARs) x (ROUTEs)/(AREAs) = a positive integer.

4. A partially interconnected network as claimed in Claim 1, wherein there are an equal number (CHOICEs) of interconnection ROUTEs between any two Allocated Nodes in different AREAs.

5. A partially interconnected network as claimed in Claim 1, wherein there are an equal number of ROUTEs from each STAR.

6. A partially interconnected network as claimed in any preceding claim, where at least one of the AREAs contains one Allocated Node.

7. A partially interconnected network as claimed in any preceding claim, wherein each point-to-point interconnection comprises a multiple circuit transmission system.

8. A partially interconnected network as claimed in any preceding claim, wherein at least one of the point-to-point interconnections passes through an AREA Cross-connect.

9. A partially interconnected network as claimed in any preceding Claim, wherein the plurality of STAR Nodes equals the number of AREAs or an integer multiple thereof and the number of AREAs and the plurality of STAR Nodes are each cyclically identified and wherein the modulo differences of the identities allocated to the cyclically identified STAR Nodes in the set or sets, selected in pairs within a set, form a single contiguous sequence or multiple contiguous sequences respectively, from one to one less than the number of cyclically identified AREAs, the remainder of the cyclically identified AREAs being interconnected each to a corresponding set of cyclically identified STAR Nodes which are each sequentially rotated by one from a former contiguous sequence to create a regular rotated interconnection pattern or regular rotated interconnection patterns.

10. A partially interconnected network as claimed in Claim 9 wherein in the pattern or patterns each cyclically identified STAR Node is interconnected to a cyclically identified AREA having the same cyclical identifier as the STAR Node.

11. A partially interconnected network as claimed in Claim 9 or 10, wherein the rotated contiguous sequence is transformed by reordering and/or renumbering the AREAs and/or reordering and/or renumbering the STAR Nodes whilst retaining an equal number of interconnection ROUTEs between any two Allocated Nodes in different AREAs, where a interconnection route comprises two point-to-point interconnections interconnected in series by a STAR Node.

12. A partially interconnected network as claimed in Claim 9, 10 or 11, wherein there is a second plurality of cyclically numbered STAR Nodes, equal in number to the earlier plurality of cyclically numbered STAR Nodes creating a second interconnection pattern, where the second interconnection pattern is a counter rotating version of the pattern of interconnections of the earlier plurality of cyclically numbered STAR Nodes.

13. A partially interconnected network as claimed in Claim 3, or any claim appendent thereto, wherein ROUTEs is a prime number or an integer power of a prime number, AREAs equals Routes^2 and STARs equals ROUTEs x (ROUTEs-1).

14 A partially interconnected network as claimed in Claim 3, wherein there is an odd integer number of STARs, each Star having three ROUTEs interconnected thereto.

15. A partially interconnected network as claimed in any preceding claim, wherein AREA Nodes and STAR Nodes share sites and where redundant pairs of point-to-point interconnections of a twin CHOICE network do not have their terminations on the same pair of sites.

16. A partially interconnected network as claimed in Claim 4, wherein: (AREAs)x(AREAs-1)x (CHOICEs) = (STARs1) x(ROUTEs1-1) + (STARs2) x(ROUTEs2-1) + (STARs3) x(ROUTEs3-1)+..... +(STARsn) x (ROUTEn-1).

17. A partially interconnected network as claimed in any preceding claim, wherein at least one STAR comprises a plurality of distributed switches interconnected to form a mesh network.

18. A partially interconnected network as claimed in any preceding claim, wherein at least one STAR comprises a plurality of routers interconnected to form a mesh network

19. A partially interconnected network as claimed in any preceding claim, wherein each ROUTE comprises a Wave Division Multiplex link.

20. A partially interconnected network as claimed in Claim 19, wherein the number of wavelengths carried by each link is one less than the number of ROUTEs.

21. A partially interconnected network as claimed in Claim 19 or 20, wherein individual wavelengths from one input WDM link are selectively taken to different output WDM links.

22. A partially interconnected network as claimed in any preceding claim, wherein one or more AREAs are without any Allocated Nodes.

23. A partially interconnected network as claimed in Claim 5 and having Extra paths(EXTRA), wherein:
(AREAs) x (AREAs-1) x (CHOICEs)= (STARs) x{(ROUTEs)x(ROUTEs-1)-(EXTRA)}

24. A partially interconnected network as claimed in Claim 5 and having Missing paths(MISSSING), wherein:
(AREAs) x (AREAs-1) x(CHOICEs)= (STARs) x{(ROUTEs)x(ROUTEs-1)+(MISSING)}.

25. A partially interconnected network as claimed in Claim 1, 2, 4 or 5, comprising a number of AREAs interconnected to a further partially interconnected network having an equivalent number of AREAs and a lesser number of STARs.

26. A plurality of partially interconnected networks, each as claimed in Claim 1, each partially interconnected network having the same number of STARs, wherein a corresponding STAR of each partially interconnected network is interconnected by a respective mesh network

27. A partially interconnected network as claimed in any preceding claim, wherein the partially interconnected network is a telecommunications network.

28. A three-stage switch where there are at least four interconnection choices (CHOICEs) between each pair of stages, wherein each pair of stages is connected by a partially interconnected network as claimed in any preceding claim.

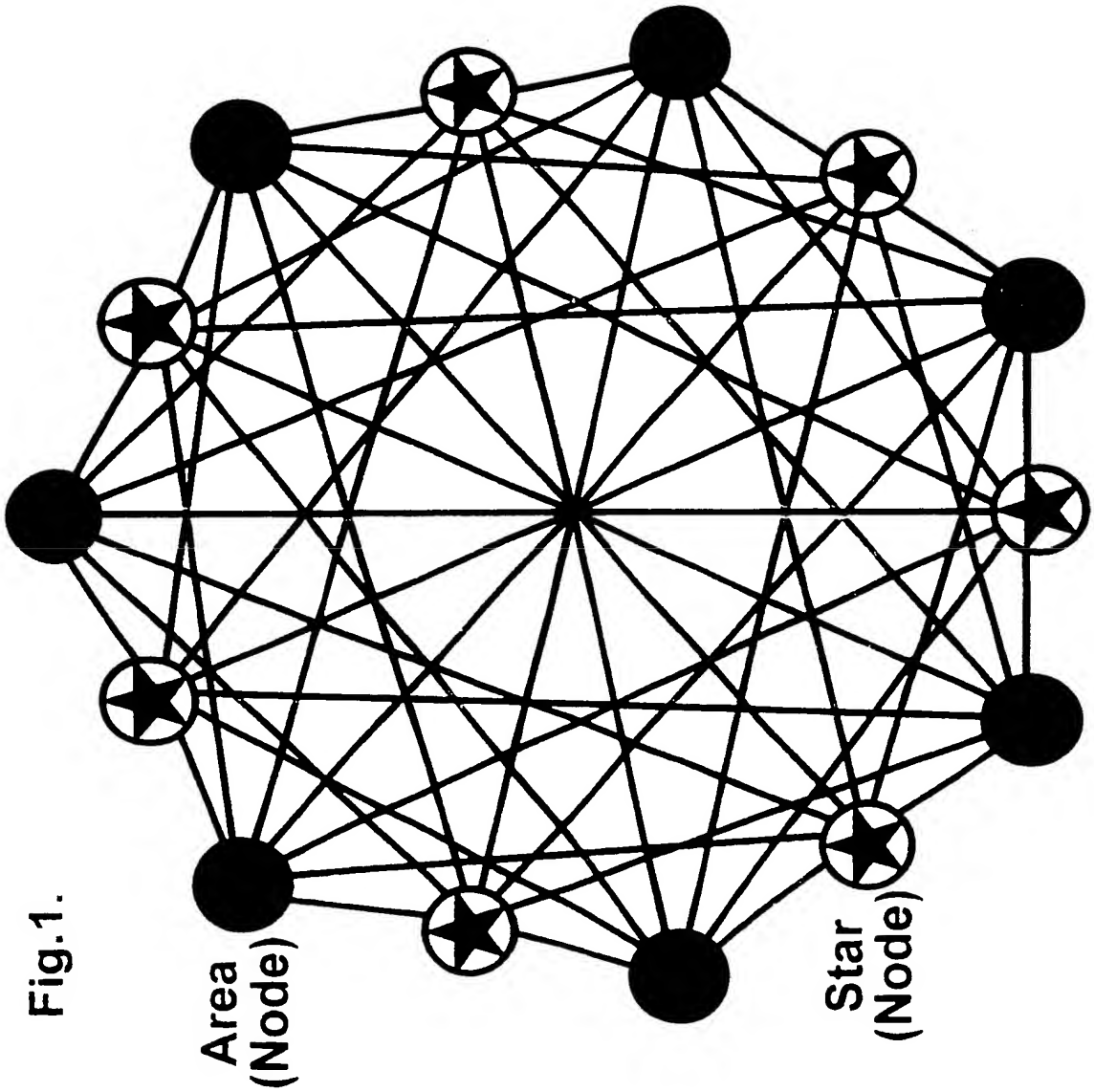


Fig.1.

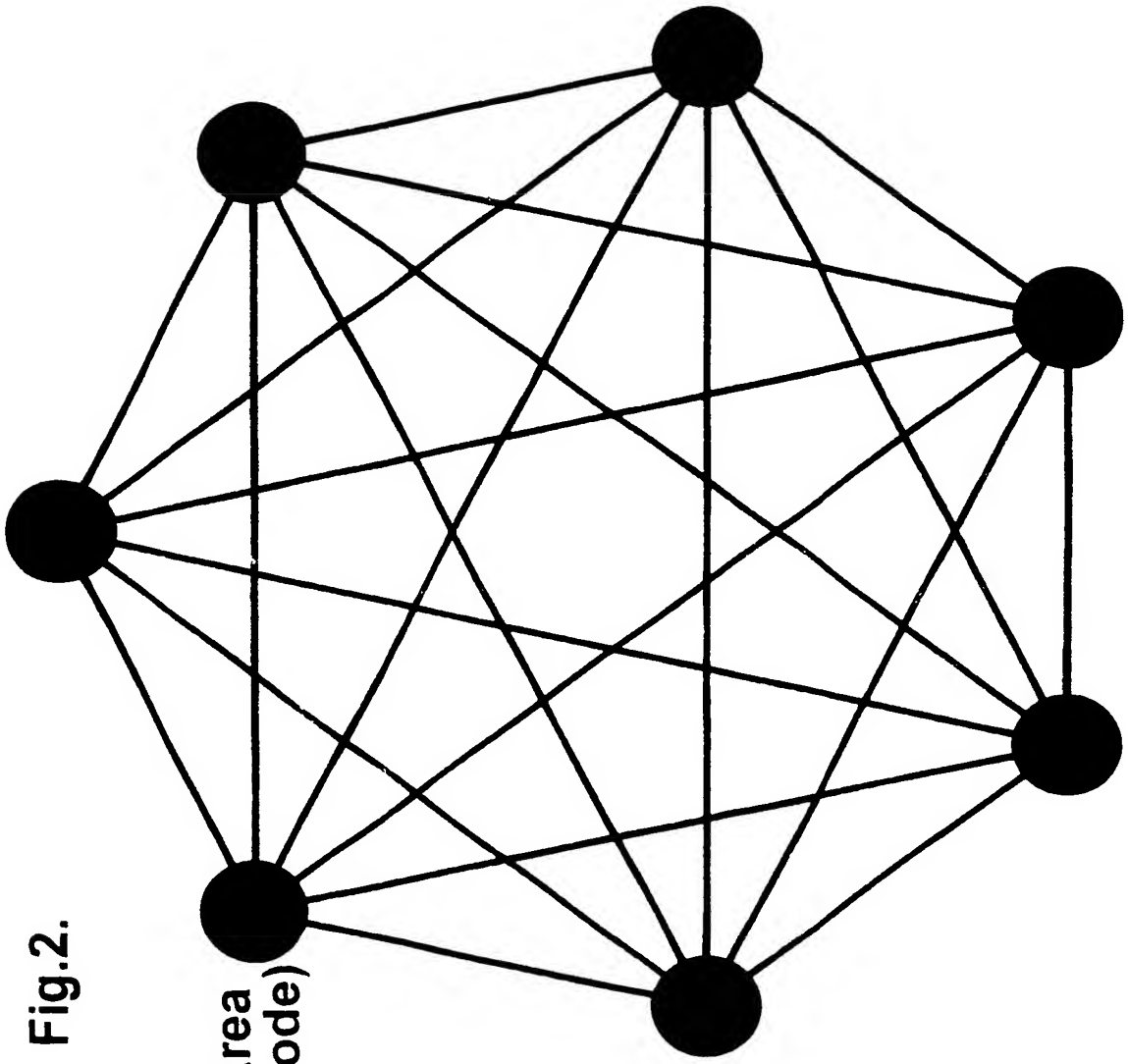


Fig.2.

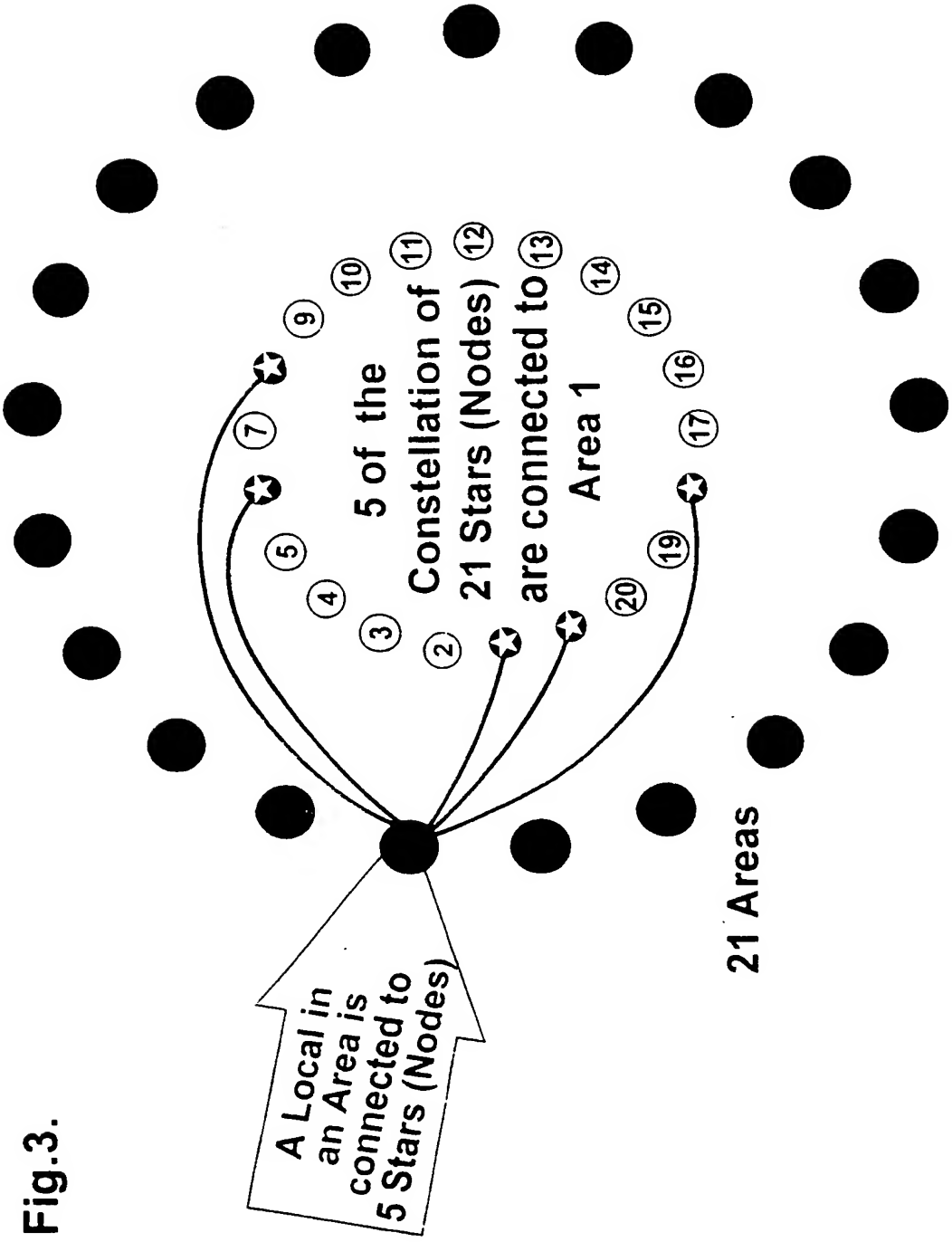

5 of the
Constellation of
21 Stars (Nodes)
are connected to
Area 1
A Local in
an Area is
connected to
5 Stars (Nodes)
21 Areas

Fig.3.

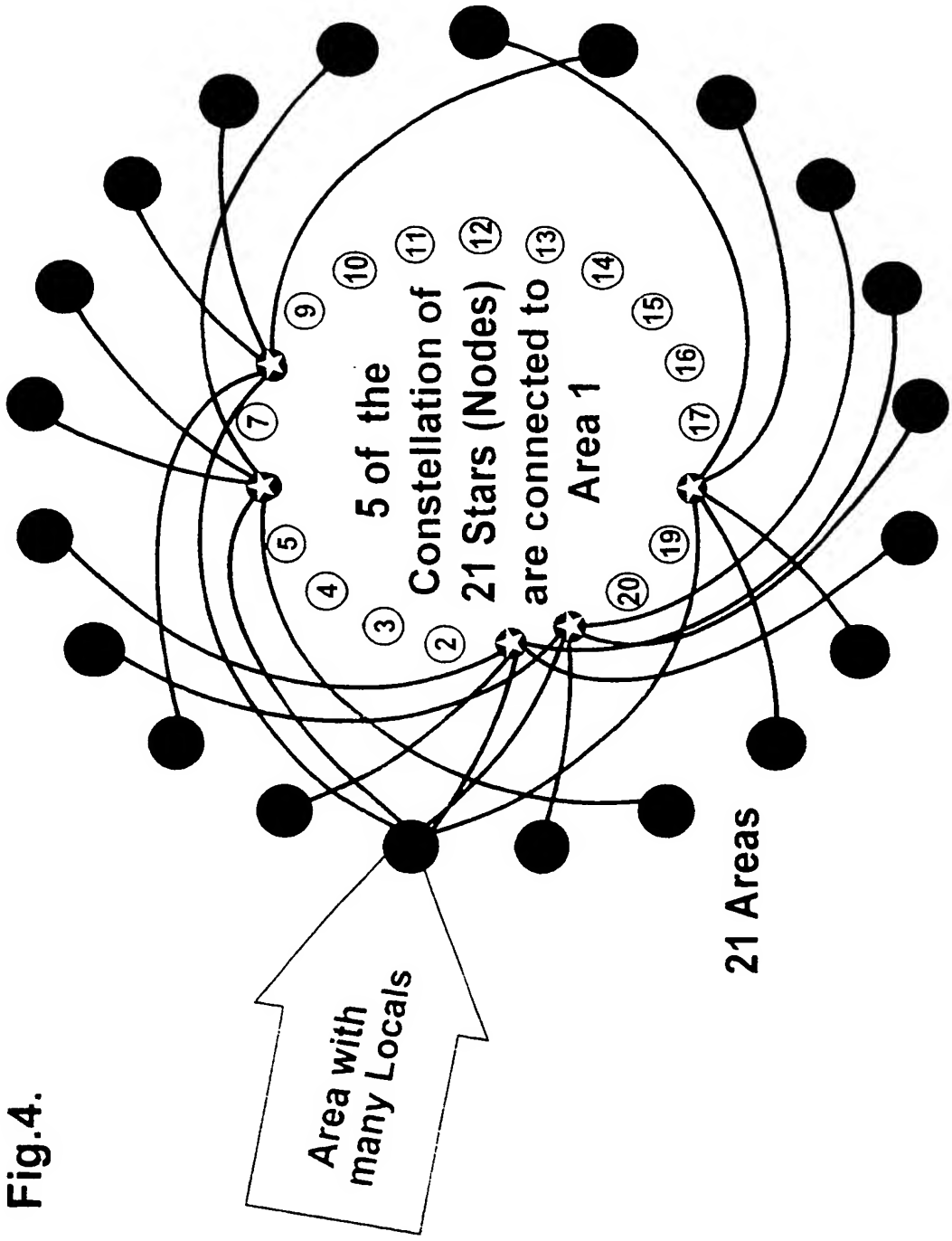

5 of the
Constellation of
21 Stars (Nodes)
are connected to
Area 1
1
2
3
4
5
7
9
10
11
12
13
14
15
16
17
19
20
21 Areas
Area with
many Locals

Fig.4.

Fig.5.

Single STARS	AREAS > 1	> 2	> 3	> 4	> 5	> 6	> 7	> 8	> 9	> 10	> 11	> 12	> 13	> 14	> 15	> 16	> 17	> 18	> 19	> 20	> 21
1	1	1			1								1		1						
2		1	1			1								1		1					
3			1	1			1								1		1				
4				1	1			1								1		1			
5					1	1			1								1		1		
6	1					1	1			1								1			
7		1					1	1			1								1		
8	1		1					1	1			1									
9		1		1					1	1			1								
10			1		1					1	1			1							
11				1		1					1	1			1						
12					1		1					1	1			1					
13						1		1					1	1			1				
14							1		1					1	1			1			
15								1		1					1	1			1		
16									1		1					1	1			1	
17										1		1					1	1			1
18	1										1		1					1	1		
19		1										1		1					1	1	
20			1										1		1					1	1
21	1			1										1		1					1

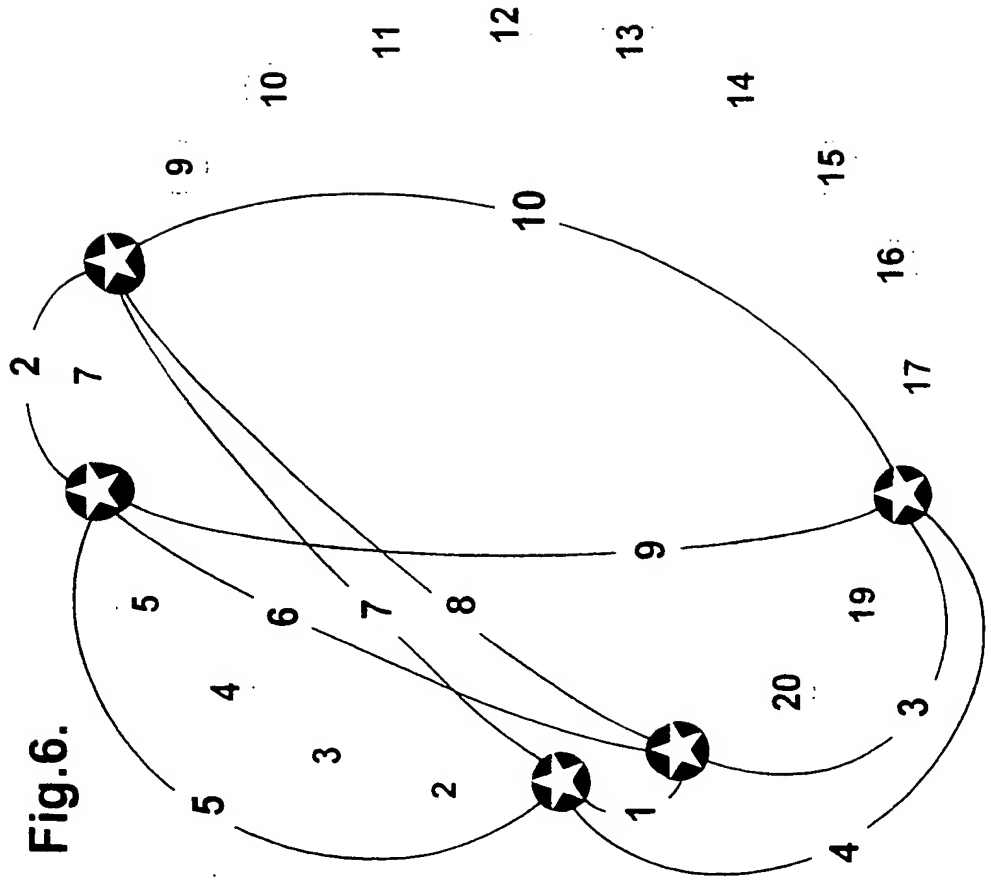


Fig.6.

Fig.7.

	AREAS >
Single	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2
STARS	1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
1	1 . . . . 1 . 1 . . . . 1 . . . 1
2	1 1 . . . . 1 . 1 . . . . 1 . .
3	. 1 1 . . . . 1 . 1 . . . . 1 .
4	. . 1 1 . . . . 1 . 1 1
5	1 . . 1 1 . . . . 1 . 1 . . . .
6	. 1 . . 1 1 . . . . 1 . 1 . . . .
7	. . 1 . . 1 1 . . . . 1 . 1 . . . . . .
8	. . . 1 . . 1 1 . . . . 1 . 1 . . . . .
9	. . . . 1 . . 1 1 . . . . 1 . 1 . . . .
10	. . . . . 1 . . 1 1 . . . . 1 . 1 . . .
11	. . . . . . 1 . . 1 1 . . . . 1 . 1 . .
12	. . . . 1 . . 1 1 . . . . 1 . 1 .
13	. . . . 1 . . 1 1 . . . . 1 . 1
14	. . . . 1 . . 1 1 . . . . 1 .
15	1 . . . . 1 . . 1 1 1
16	. 1 . . . . 1 . . 1 1 . . . .
17	1 . 1 . . . . 1 . . 1 1 . . .
18	. 1 . 1 . . . . 1 . . 1 1 . .
19	. . 1 . 1 . . . . 1 . . 1 1 .
20	. . . 1 . 1 . . . . 1 . . 1 1
21	. . . . 1 . 1 . . . . 1 . . 1 1

Fig.8.

	AREAS >
Single	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2
STARS	1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
1	1 1 1 1 1 1
2	1 . . . . 1 1 1 1 6
3	1 . . . . 1 1 1 1 8
4	1 . . . . 1 1 1 1 . . . 18
5	1 . . . . 1 1 1 1 21
6	. 1 . . . 1 . . . 1 . . . . 1 . . . 1 . . 2
7	. 1 . . . . 1 . . . 1 . . . . 1 . . . 1 . 7
8	. 1 . . . . . 1 . . . 1 . . . 1 . . . 1 9
9	. 1 . . . . . . 1 . . . 1 . . . 1 . . . 1 19
10	. . 1 . . 1 . . . . . 1 . . . 1 . 1 . . 5
11	. . 1 . . . 1 . . . . . 1 . . 1 . 1 . . 12
12	. . 1 . . . . 1 . 1 . . . . 1 . . . . 1 10
13	. . 1 . . . . . 1 . 1 . . . 1 . . . . 1 . 4
14	. . . 1 . 1 . . . . . . 1 . 1 . . . . 1 . 11
15	. . . 1 . . 1 . . . . 1 . 1 . . . . . 1 14
16	. . . 1 . . . 1 . . 1 . . . . . 1 1 . . 15
17	. . . 1 . . . . 1 1 . . . . 1 . . 1 . . 20
18	. . . . 1 1 . . . . 1 . . . . 1 . . . 1 13
19	. . . . 1 . 1 . . 1 . . . . . 1 . . 1 . 3
20	. . . . 1 . . 1 . . . . 1 1 . . . . 1 . 17
21	. . . . 1 . . . 1 . . 1 . . 1 . . 1 . . 16
	0 0 0 1 1 0 0 1 2 0 0 0 1 1 1 1 1 1 2 0 1
	1 2 5 5 7 6 7 0 0 3 8 9 2 8 1 3 9 6 1 4 4

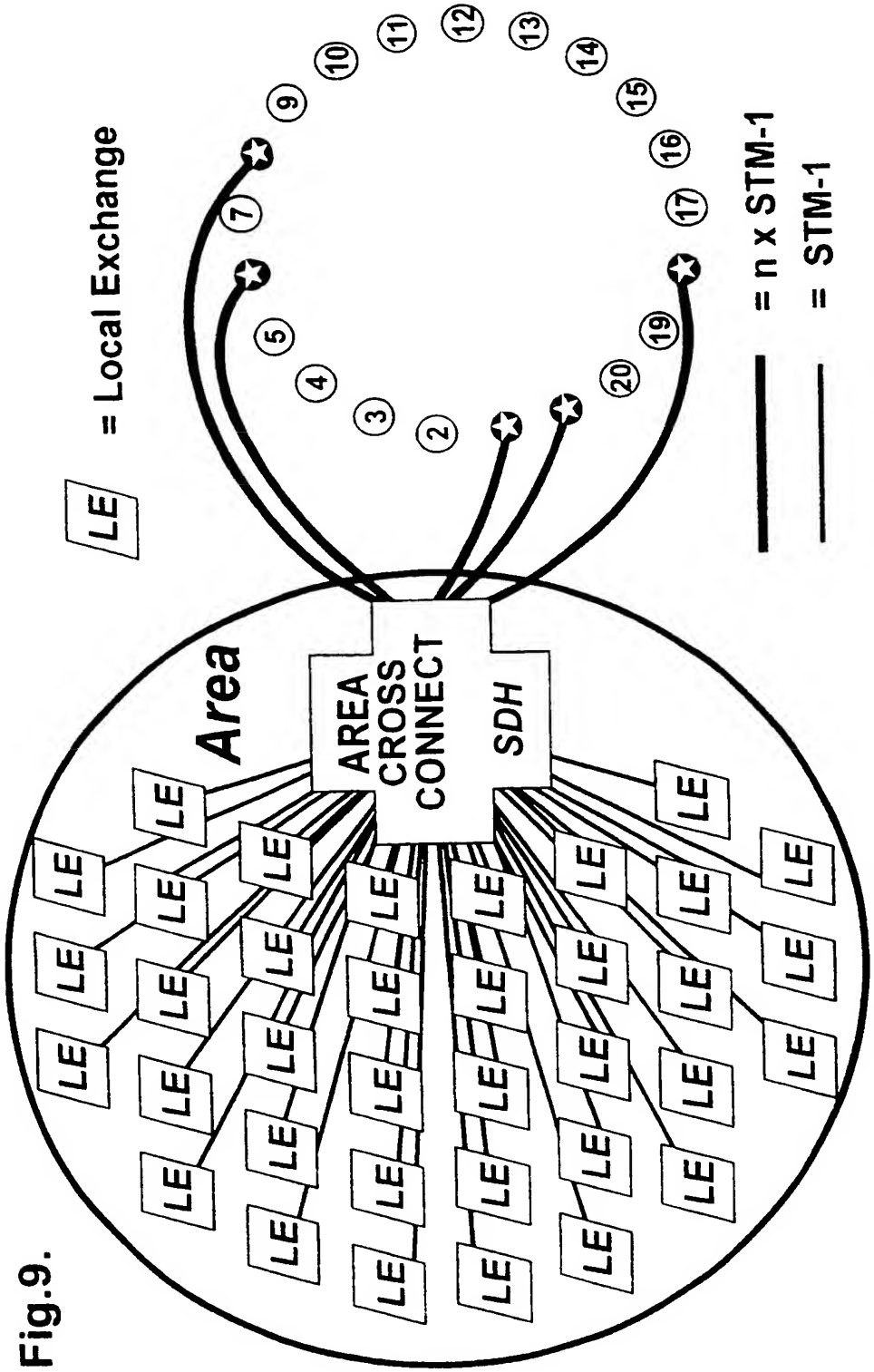

LE
= Local Exchange
= n x STM-1
= STM-1
Area
AREA CROSS CONNECT
SDH
LE

Fig.9.

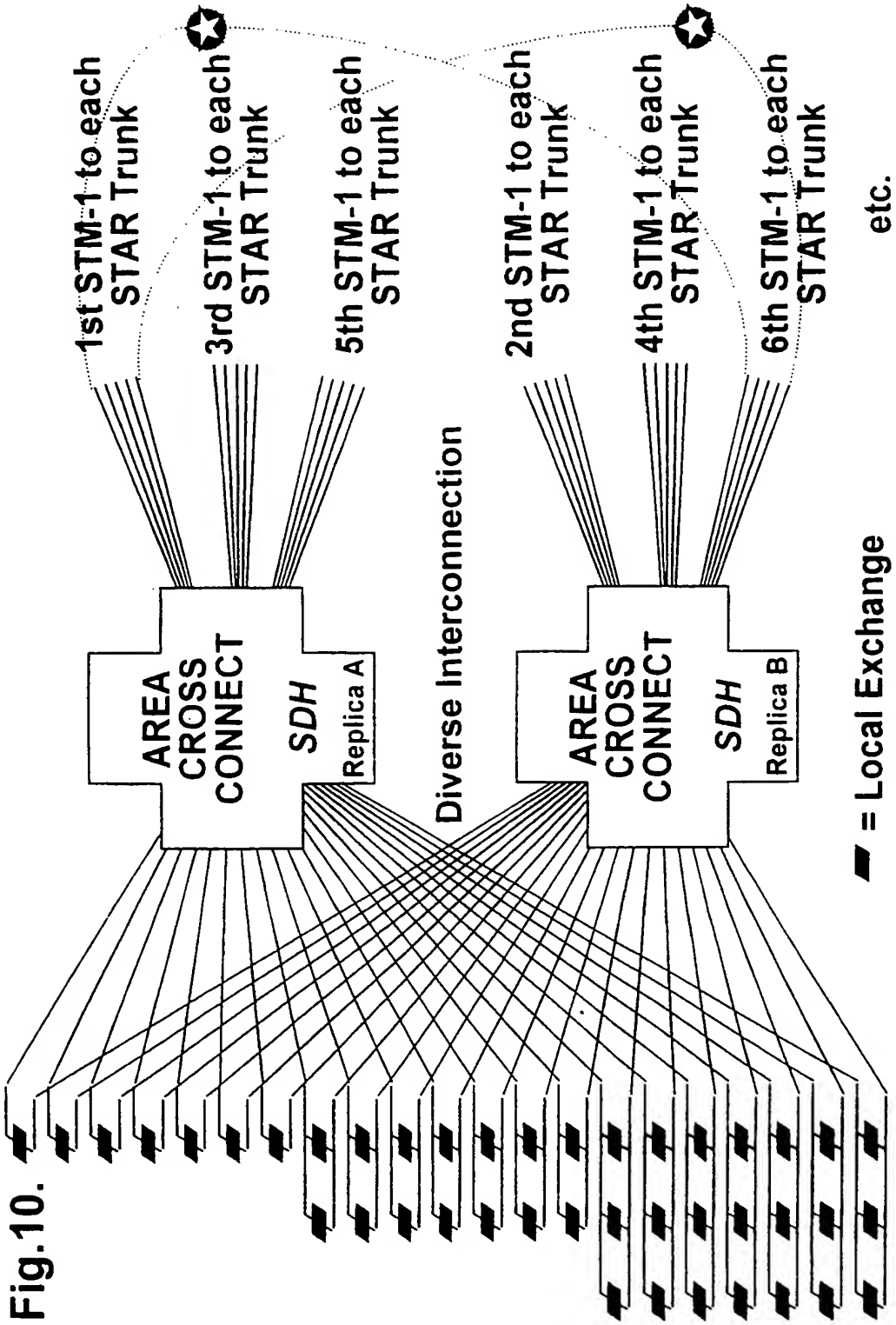

1st STM-1 to each STAR Trunk
3rd STM-1 to each STAR Trunk
5th STM-1 to each STAR Trunk
2nd STM-1 to each STAR Trunk
4th STM-1 to each STAR Trunk
6th STM-1 to each STAR Trunk
etc.
AREA CROSS CONNECT
SDH
Replica A
AREA CROSS CONNECT
SDH
Replica B
Diverse Interconnection
= Local Exchange

Fig.10.

Fig.11.

AREAS CHOICES	STARS ROUTES	Fig.	
A (A-1) C = S (R)(R-1)			EXAMPLES OF ROTATIONAL PATTERNS
3 (2) 1 = 3 (2)(1)			1 2
7 (6) 1 = 7 (3)(2)			1 2 4 #7
13 (12) 1 = 13 (4)(3)			1 2 5 7 #4
21 (20) 1 = 21 (5)(4)		5	1 2 5 15 17
31 (30) 1 = 31 (6)(5)			1 2 9 12 14 18
57 (56) 1 = 57 (8)(7)			1 2 4 14 33 37 44 53
73 (72) 1 = 73 (9)(8)			1 2 4 8 16 32 37 55 64
91 (90) 1 = 91 (10)(9)			1 2 4 10 28 50 57 62 78 82
133 (132) 1 = 133 (12)(11)			1 2 4 13 21 35 39 82 89 95 105 110
4 (3) 2 = 4 (3)(2)			1 2 3 #4
7 (6) 2 = 7 (4)(3)		13	1 2 4 7 #7
11 (10) 2 = 11 (5)(4)			1 2 4 7 11
37 (36) 2 = 37 (9)(8)			1 2 4 8 18 25 26 30 36
5 (4) 3 = 5 (4)(3)			1 2 3 4
11 (10) 3 = 11 (6)(5)		14	1 2 3 5 6 8
15 (14) 3 = 15 (7)(6)			1 2 3 5 6 9 11 #7
6 (5) 4 = 6 (5)(4)			1 2 3 4 5
15 (14) 4 = 15 (8)(7)			1 2 3 4 6 8 9 12
19 (18) 4 = 19 (9)(8)		15	1 2 3 4 6 8 13 14 17
7 (6) 5 = 7 (6)(5)			1 2 3 4 5 6
19 (18) 5 = 19 (10)(9)		16	1 2 3 4 6 8 13 14 16 17
23 (22) 5 = 23 (11)(10)			1 2 3 4 6 8 9 12 13 16 18
8 (7) 6 = 8 (7)(6)			1 2 3 4 5 6 7
23 (22) 6 = 23 (12)(11)			1 2 3 4 5 7 9 10 13 14 17 19
			EXAMPLES OF MULTI-ROTATIONAL PATTERNS
13 (12) 1 = 26 (3)(2)			1 2 5 1 2 8
19 (18) 1 = 57 (3)(2)			1 2 5 1 3 10 1 6 12
25 (24) 1 = 100 (3)(2)			1 2 3 1 5 12 1 6 14 1 7 16
31 (30) 1 = 155 (3)(2)			1 2 4 1 5 12 1 6 16 1 7 19 1 9 18
37 (36) 1 = 111 (4)(3)			1 2 4 25 1 5 10 16 1 8 18 26
16 (15) 2 = 80 (3)(2)			1 2 4 1 2 6 1 3 9 1 4 10 1 5 10
19 (18) 2 = 57 (4)(3)			1 2 5 10 1 3 4 10 1 6 8 10
31 (30) 2 = 93 (5)(4)			1 2 7 9 19 1 2 5 7 16 1 4 12 16 25
5 (4) 3 = 10 (3)(2)		18	1 2 3 1 2 4
			EXAMPLES OF OTHER ROTATIONAL PATTERNS
13 (12) 2 = 52 (3)(2)			Stars with 4 routes replaced by four stars with 3 Routes #4
15 (14) 3 = 105 (3)(2)			Stars with 7 routes replaced by seven stars with 3 Routes #7

Fig.12.

AREAS CHOICES			STARS ROUTES	Fig.					
				11/36					
16 (15) **2**	=	**16** (6)(5)	22 23						
16 (15) **1**	=	**20** (4)(3)	20 21						**#4**
12 (44) **3**	=	**44** (3)(2)	19						
10 (9) **2**	=	**15** (4)(3)	24						
8 (7) **3**	=	**14** (4)(3)	25						
6 (5) **2**	=	**10** (3)(2)	26						
9 (8) **1**	=	**12** (3)(2)	27 28	A=RxR	S=R(R+1)	R = odd integer	R= 3	A= 9	S= 12
25 (24) **1**	=	**30** (5)(4)	29	A=RxR	S=R(R+1)	R = odd integer	R= 5	A= 25	S= 30
49 (48) **1**	=	**56** (7)(6)	30	A=RxR	S=R(R+1)	R = odd integer	R= 7	A= 49	S= 56 **#7**
81 (80) **1**	=	**90** (9)(8)		A=RxR	S=R(R+1)	R = odd integer	R= 9	A= 81	S= 90
121 (120) **1**	=	**132** (11)(10)		A=RxR	S=R(R+1)	R = odd integer	R= 11	A=121	S=132
169 (168) **1**	=	**182** (13)(12)		A=RxR	S=R(R+1)	R = odd integer	R= 13	A=169	S=182
225 (224) **1**	=	**240** (15)(14)		A=RxR	S=R(R+1)	R = odd integer	R= 15	A=225	S=240
289 (288) **1**	=	**306** (17)(16)		A=RxR	S=R(R+1)	R = odd integer	R= 17	A=289	S=306
361 (360) **1**	=	**380** (19)(18)		A=RxR	S=R(R+1)	R = odd integer	R=19	A=361	S=380
		etc.							
15 (14) **1**	=	**35** (3)(2)	31	Odd number of Groups: each Group = 3 Areas: R=3					
21 (20) **1**	=	**70** (3)(2)	32	Odd number of Groups: each Group = 3 Areas: R=3					
27 (26) **1**	=	**117** (3)(2)	33	Odd number of Groups: each Group = 3 Areas: R=3					
33 (32) **1**	=	**176** (3)(2)		Odd number of Groups: each Group = 3 Areas: R=3					
39 (38) **1**	=	**247** (3)(2)		Odd number of Groups: each Group = 3 Areas: R=3					
45 (44) **1**	=	**330** (3)(2)		Odd number of Groups: each Group = 3 Areas: R=3					
51 (50) **1**	=	**425** (3)(2)		Odd number of Groups: each Group = 3 Areas: R=3					
		etc.							
16 (15) **2**	=	**80** (3)(2)		Stars with 4 routes replaced by four stars with 3 Routes					**#4**
49 (48) **1**	=	**392** (3)(2)		Stars with 7 routes replaced by seven stars with 3 Routes					**#7**
49 (48) **2**	=	**392** (4)(3)		Stars with 7 routes replaced by seven stars with 4 Routes					**#7**

Fig.13. Twin

STARS	AREAS 0 0 0 0 0 0 0						
	1	2	3	4	5	6	7
1	1	1		1			1
2	1	1	1		1		
3		1	1	1		1	
4			1	1	1		1
5	1			1	1	1	
6		1			1	1	1
7	1		1			1	1

Fig.14. Triple

STARS	AREAS > > > > > 0 0 0 0 0 0 0 1 1										
	1	2	3	4	5	6	7	8	9	0	1
1	1	1	1		1	1		1			
2		1	1	1		1	1		1		
3			1	1	1		1	1		1	
4				1	1	1		1	1		1
5	1				1	1	1		1	1	
6		1				1	1	1		1	1
7	1		1				1	1	1		1
8	1	1		1				1	1	1	
9		1	1		1				1	1	1
10	1		1	1		1				1	1
11	1	1		1	1		1				1

Fig.15. Quad

STARS	AREAS > > > > > > > > > > > > > > > > > > > 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1																			
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
1	1	1	1	1		1		1					1	1			1		
2		1	1	1	1		1		1					1	1			1	
3			1	1	1	1		1		1					1	1			1
4	1			1	1	1	1		1		1					1	1		
5		1			1	1	1	1		1		1					1	1	
6			1			1	1	1	1		1		1					1	1
7	1			1			1	1	1	1		1		1					1
8	1	1			1			1	1	1	1		1		1				
9		1	1			1			1	1	1	1		1		1			
10			1	1			1			1	1	1	1		1		1		
11				1	1			1			1	1	1	1		1		1	
12					1	1			1			1	1	1	1		1		1
13	1					1	1			1			1	1	1	1		1	
14		1					1	1			1			1	1	1	1		1
15	1		1					1	1			1			1	1	1	1	
16		1		1					1	1			1			1	1	1	1
17	1		1		1					1	1			1			1	1	1
18	1	1		1		1					1	1			1			1	1
19	1	1	1		1		1					1	1			1			1

Fig.16. Quin

STARS	AREAS > > > > > > > > > > > > > > > > > > > 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1																			
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
1	1	1	1	1		1		1					1	1		1	1		
2		1	1	1	1		1		1					1	1		1	1	
3			1	1	1	1		1		1					1	1		1	1
4	1			1	1	1	1		1		1					1	1		1
5	1	1			1	1	1	1		1		1					1	1	
6		1	1			1	1	1	1		1		1					1	1
7	1		1	1			1	1	1	1		1		1					1
8	1	1		1	1			1	1	1	1		1		1				
9		1	1		1	1			1	1	1	1		1		1			
10			1	1		1	1			1	1	1	1		1		1		
11				1	1		1	1			1	1	1	1		1		1	
12					1	1		1	1			1	1	1	1		1		1
13	1					1	1		1	1			1	1	1	1		1	
14		1					1	1		1	1			1	1	1	1		1
15	1		1					1	1		1	1			1	1	1	1	
16		1		1					1	1			1	1			1	1	1
17	1		1		1					1	1			1	1			1	1
18	1	1		1		1					1	1			1	1			1
19	1	1	1		1		1					1	1			1	1		

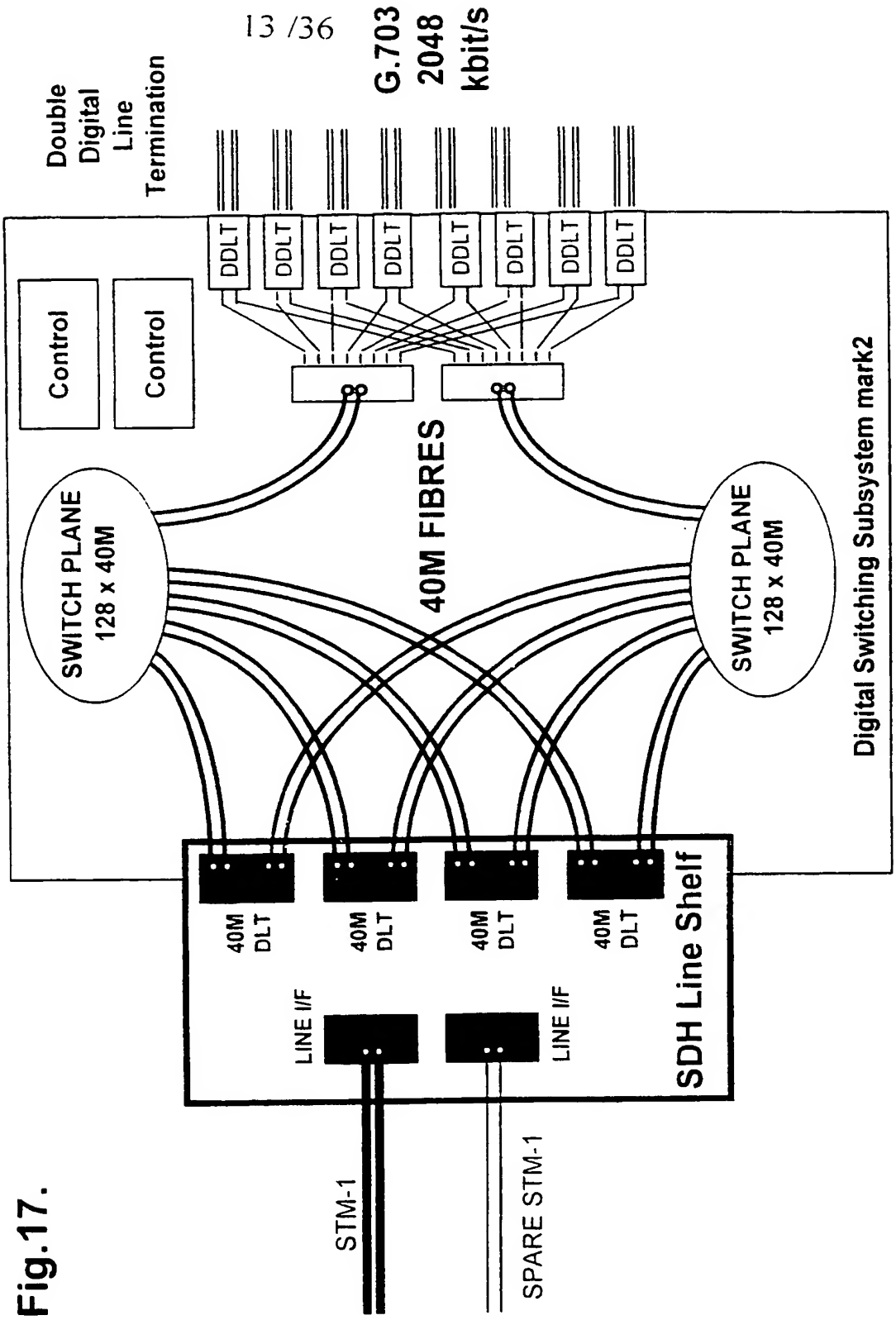

G.703
2048
kbit/s
Double
Digital
Line
Termination
DDLT
Control
Control
40M FIBRES
SWITCH PLANE
128 x 40M
SWITCH PLANE
128 x 40M
Digital Switching Subsystem mark2
40M
DLT
LINE I/F
SDH Line Shelf
STM-1
SPARE STM-1

Fig.17.

Fig.18. Triple

STARS	AREAS 1	2	3	4	5
1	1	1	1		
2		1	1	1	
3			1	1	1
4	1			1	1
5	1	1			1
6	1	1		1	
7		1	1		1
8	1		1	1	
9		1		1	1
10	1		1		1

Fig.19. Twin

STARS	AREAS 1	2	3	4	5	6	7	8	9	>10	>11	>12
1	1	1										1
2	1	1	1									
3	1		1	1								
4	1			1	1							
5	1				1	1						
6	1					1	1					
7	1						1	1				
8	1							1	1			
9	1								1	1		
10	1									1	1	
11	1										1	1
12		1			1							1
13		1	1			1						
14			1	1			1					
15				1	1			1				
16					1	1			1			
17						1	1			1		
18							1	1			1	
19								1	1			1
20		1							1	1		
21			1							1	1	
22				1							1	1
23		1		1			1					
24			1		1			1				
25				1		1			1			
26					1		1			1		
27						1		1			1	
28							1		1			1
29		1						1		1		
30			1						1		1	
31				1						1		1
32		1			1						1	
33			1			1						1
34		1		1			1					
35			1		1			1				
36				1		1			1			
37					1		1			1		
38						1		1				1
39		1					1		1			
40			1					1		1		
41				1					1		1	
42					1					1		1
43		1				1					1	
44			1				1					1

Fig.20. Twin

STARS	AREAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	1		1			1				1				1	
2	1	1	1					1				1				1
3		1	1	1	1				1				1			
4	1		1	1		1				1				1		
5			1		1	1		1			1				1	
6				1	1	1	1					1				1
7	1				1	1	1	1				1				
8		1			1		1	1		1				1		
9			1				1		1	1		1			1	
10				1				1	1	1	1					1
11	1				1					1	1	1	1			
12		1				1			1		1	1		1		
13			1				1				1		1	1		1
14				1				1				1	1	1	1	
15	1				1				1					1	1	1
16		1				1				1			1		1	1

Fig.21. Twin

STARS	AREAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		1	1	1	1				1				1			
2	1		1	1		1				1				1		
3	1	1		1			1				1				1	
4	1	1	1					1				1				1
5	1				1	1	1	1					1			
6		1			1		1	1		1				1		
7			1		1	1		1			1				1	
8				1	1	1	1					1				1
9	1				1				1	1	1	1				
10		1				1			1		1	1		1		
11			1				1		1	1		1			1	
12				1				1	1	1	1					1
13	1				1				1					1	1	1
14		1				1				1			1		1	1
15			1				1				1		1	1		1
16				1				1				1	1	1	1	

Fig.22. Single

STARS	AREAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1						1				1		1			
2		1				1			1				1			
3			1		1				1						1	
4				1				1			1				1	
5				1	1							1	1			
6				1		1				1						1
7			1				1					1				1
8	1							1	1							1
9				1			1		1					1		
10		1				1				1					1	
11			1			1					1			1		
12		1						1				1		1		
13			1					1		1			1			
14	1				1					1				1		
15	1					1						1			1	
16		1			1						1					1
17	1	1	1	1												
18					1	1	1	1								
19									1	1	1	1				
20													1	1	1	1

Fig.23. Single

STARS	AREAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	1						1		1						
2		1	1			1			1							
3			1	1			1			1						
4				1	1	1		1								
5	1				1		1		1							
6						1	1					1		1		
7							1	1			1			1		
8								1	1			1				1
9									1	1	1		1			
10						1				1		1		1		
11			1		1						1	1				
12	1			1								1	1			
13		1			1									1	1	
14	1		1												1	1
15		1		1								1				1
16	1				1							1				1
17		1				1							1			1
18			1				1							1		1
19				1				1							1	1
20					1				1							1

Fig.24. Twin — AREAS > > > > 0 0 0 0 0 0 0 0 0 1

STARS	1	2	3	4	5	6	7	8	9	0
1	1		1	1		1				
2	1	1		1	1					
3		1	1		1	1				
4				1		1	1		1	
5				1	1		1	1		
6					1	1		1	1	
7	1		1				1		1	
8	1	1					1	1		
9		1	1					1	1	
10	1			1					1	1
11		1				1	1			1
12			1	1				1		1
13	1					1		1		1
14		1		1					1	1
15			1		1		1			1

Fig.25. Triple — AREAS > > 0 0 0 0 0 0 0 0

STARS	1	2	3	4	5	6	7	8
1	1	1			1	1		
2		1	1			1	1	
3			1	1			1	1
4	1			1	1			1
5	1		1		1		1	
6		1		1		1		1
7	1	1					1	1
8		1	1		1			1
9			1	1	1	1		
10	1			1		1	1	
11	1		1			1		1
12		1		1	1		1	
13	1	1	1	1				
14					1	1	1	1

Fig.26. Twin — AREAS 0 0 0 0 0 0

STARS	1	2	3	4	5	6
1	1	1				1
2	1	1	1			
3	1		1	1		
4	1			1	1	
5	1				1	1
6		1		1		1
7		1	1		1	
8			1	1		1
9		1		1	1	
10			1		1	1

Fig.27. Single — AREAS > > > 0 0 0 0 0 0 0 0 0

STARS	1	2	3	4	5	6	7	8	9
1	1	1	1						
2				1	1	1			
3							1	1	1
4	1			1				1	
5	1				1		1		
6		1		1			1		
7		1			1				1
8		1				1		1	
9			1		1			1	
10			1			1	1		
11			1	1					1
12	1					1			1

Fig.28. Single — AREAS > > > 0 0 0 0 0 0 0 0 0

STARS	1	2	3	4	5	6	7	8	9
1	1			1			1		
2		1			1			1	
3			1			1			1
4			1	1				1	
5	1				1				1
6		1				1	1		
7			1		1		1		
8	1					1		1	
9		1		1					1
10	1	1	1						
11				1	1	1			
12							1	1	1

Fig.29.

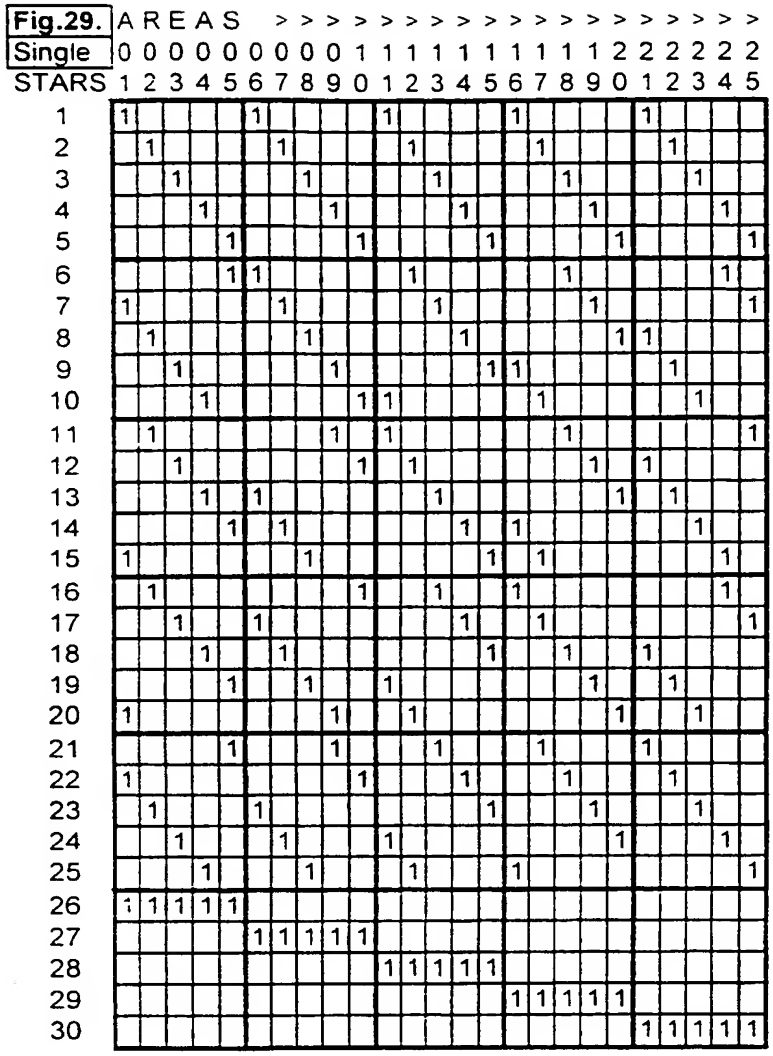

AREAS >>>>>>>>>>>>>>>>>>>>>>>>>
Single 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2
STARS 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Fig.30.

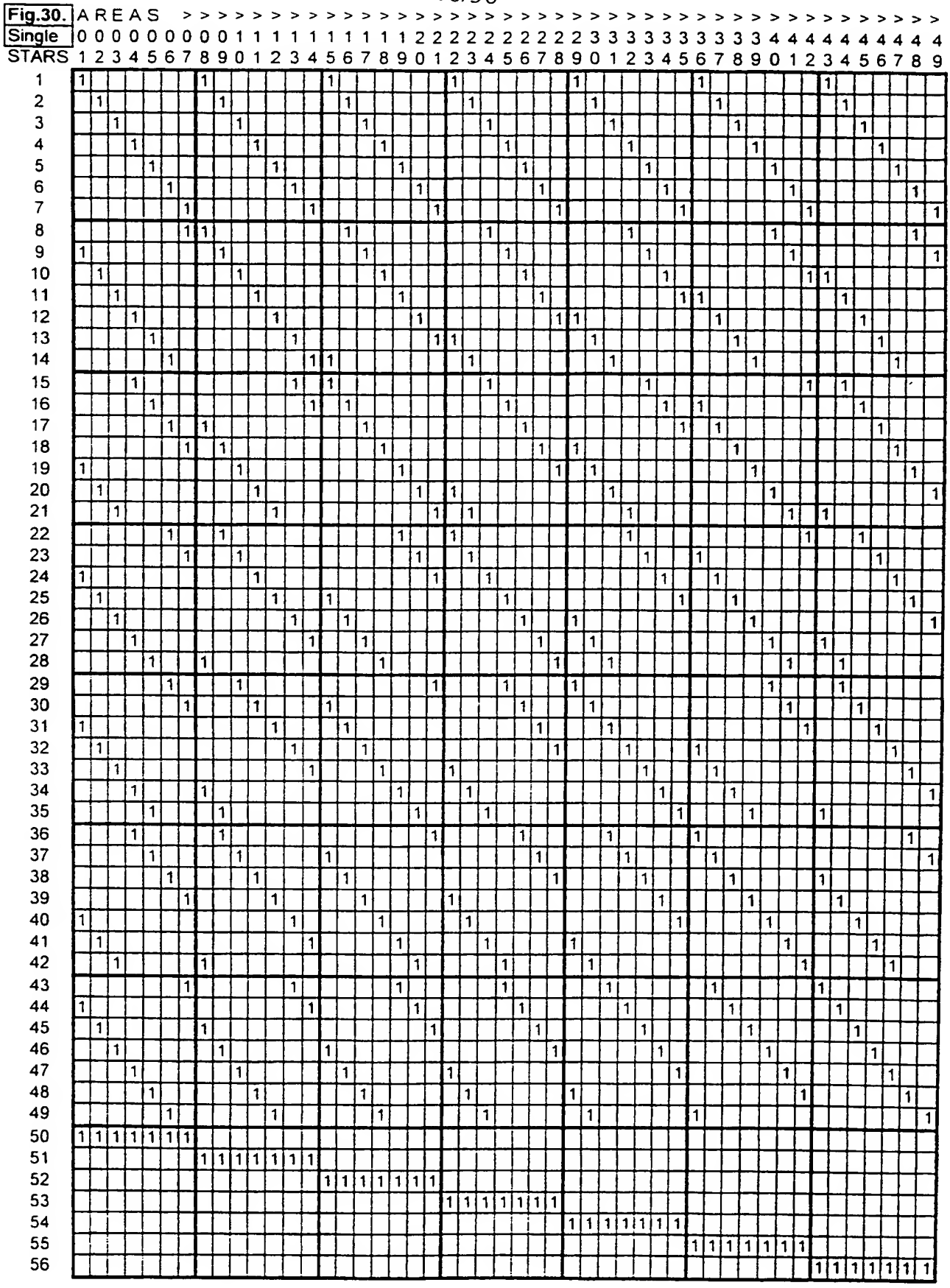


Fig.31.

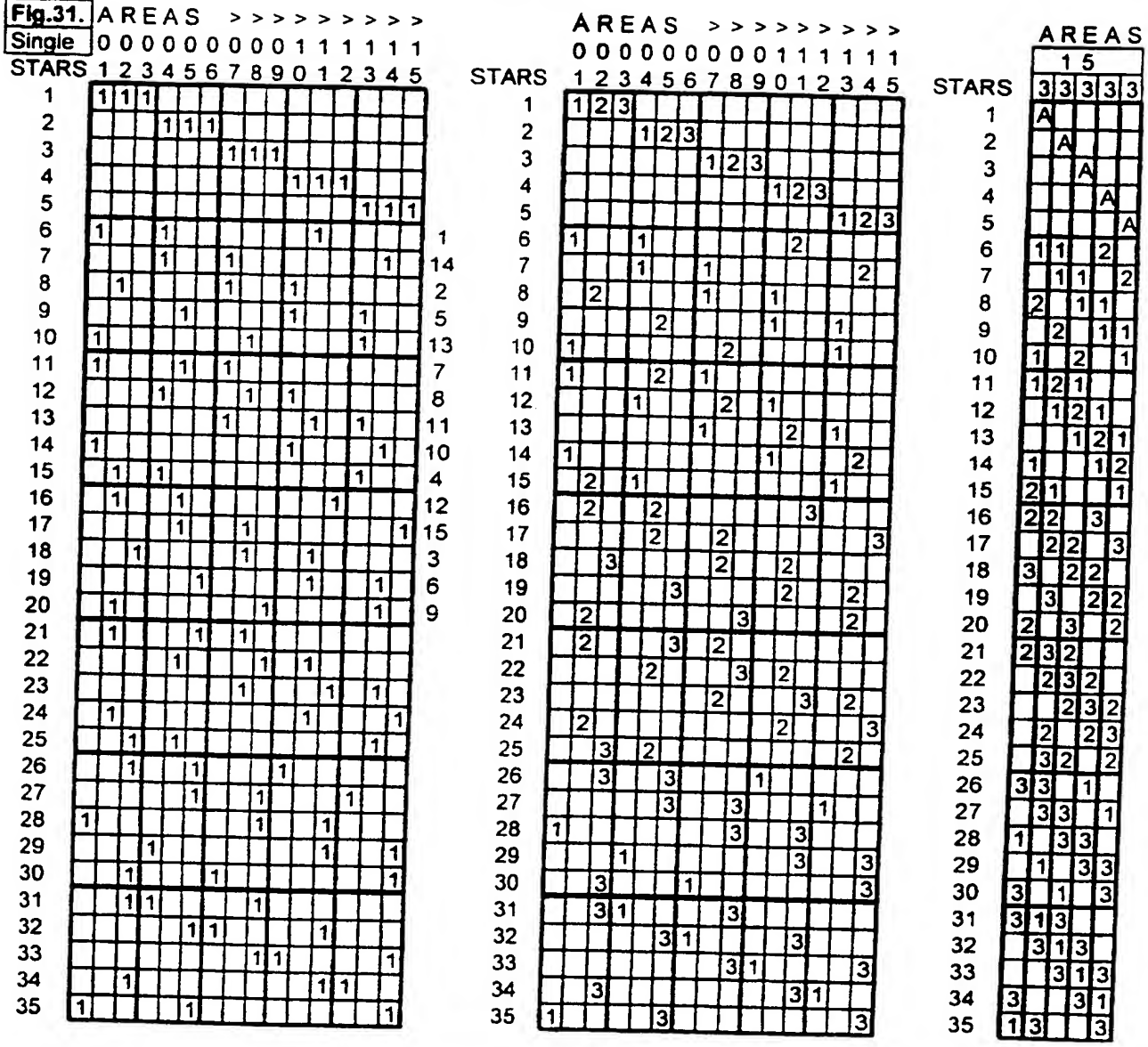

Single
AREAS
STARS
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
1 14 2 5 13 7 8 11 10 4 12 15 3 6 9
AREAS
STARS
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
AREAS
1 5
STARS
3 3 3 3 3

Fig.32.

Single STARS	AREAS 2 1						
	3	3	3	3	3	3	
1	A						
2		A					
3			A				
4				A			
5					A		
6						A	
7							A
8	1	1			2		
9		1	1			2	
10			1	1			2
11	2			1	1		
12		2			1	1	
13			2			1	1
14	1			2			1
15	1	2	1				
16		1	2	1			
17			1	2	1		
18				1	2	1	
19					1	2	1
20	1					1	2
21	2	1					1
22	1			1		2	
23		1			1		2
24	2		1			1	
25		2		1			1
26	1		2		1		
27		1		2		1	
28			1		2		1

	AREAS 2 1						
	3	3	3	3	3	3	
29	2	2			3		
30		2	2			3	
31			2	2			3
32	3			2	2		
33		3			2	2	
34			3			2	2
35	2			3			2
36	2	3	2				
37		2	3	2			
38			2	3	2		
39				2	3	2	
40					2	3	2
41	2					2	3
42	3	2					2
43	2			2		3	
44		2			2		3
45	3		2			2	
46		3		2			2
47	2		3		2		
48		2		3		2	
49			2		3		2

	AREAS 2 1						
	3	3	3	3	3	3	
50	3	3			1		
51		3	3			1	
52			3	3			1
53	1			3	3		
54		1			3	3	
55			1			3	3
56	3			1			3
57	3	1	3				
58		3	1	3			
59			3	1	3		
60				3	1	3	
61					3	1	3
62	3					3	1
63	1	3					3
64	3			3		1	
65		3			3		1
66	1		3			3	
67		1		3			3
68	3		1		3		
69		3		1		3	
70			3		1		3

Fig.33.

Single	AREAS 27								
STARS	3	3	3	3	3	3	3	3	3
1	A								
2		A							
3			A						
4				A					
5					A				
6						A			
7							A		
8								A	
9									A
10	1	1				2			
11		1	1				2		
12			1	1				2	
13				1	1				2
14	2				1	1			
15		2				1	1		
16			2				1	1	
17				2				1	1
18	1				2				1
19	1	2	1						
20		1	2	1					
21			1	2	1				
22				1	2	1			
23					1	2	1		
24						1	2	1	
25							1	2	1
26	1							1	2
27	2	1							1
28	1			1			2		
29		1			1			2	
30			1			1			2
31	2			1			1		
32		2			1			1	
33			2			1			1
34	1			2			1		
35		1			2			1	
36			1			2			1
37	1		2		1				
38		1		2		1			
39			1		2		1		
40				1		2		1	
41					1		2		1
42	1					1		2	
43		1					1		2
44	2		1					1	
45		2		1					1

	AREAS 27								
	3	3	3	3	3	3	3	3	3
46	2	2				3			
47		2	2				3		
48			2	2				3	
49				2	2				3
50	3				2	2			
51		3				2	2		
52			3				2	2	
53				3				2	2
54	2				3				2
55	2	3	2						
56		2	3	2					
57			2	3	2				
58				2	3	2			
59					2	3	2		
60						2	3	2	
61							2	3	2
62	2							2	3
63	3	2							2
64	2			2			3		
65		2			2			3	
66			2			2			3
67	3			2			2		
68		3			2			2	
69			3			2			2
70	2			3			2		
71		2			3			2	
72			2			3			2
73	2		3		2				
74		2		3		2			
75			2		3		2		
76				2		3		2	
77					2		3		2
78	2					2		3	
79		2					2		3
80	3		2					2	
81		3		2					2

	AREAS 27								
	3	3	3	3	3	3	3	3	3
82	3	3				1			
83		3	3				1		
84			3	3				1	
85				3	3				1
86	1				3	3			
87		1				3	3		
88			1				3	3	
89				1				3	3
90	3				1				3
91	3	1	3						
92		3	1	3					
93			3	1	3				
94				3	1	3			
95					3	1	3		
96						3	1	3	
97							3	1	3
98	3							3	1
99	1	3							3
100	3			3			1		
101		3			3			1	
102			3			3			1
103	1			3			3		
104		1			3			3	
105			1			3			3
106	3			1			3		
107		3			1			3	
108			3			1			3
109	3		1		3				
110		3		1		3			
111			3		1		3		
112				3		1		3	
113					3		1		3
114	3					3		1	
115		3					3		1
116	1		3					3	
117		1		3					3

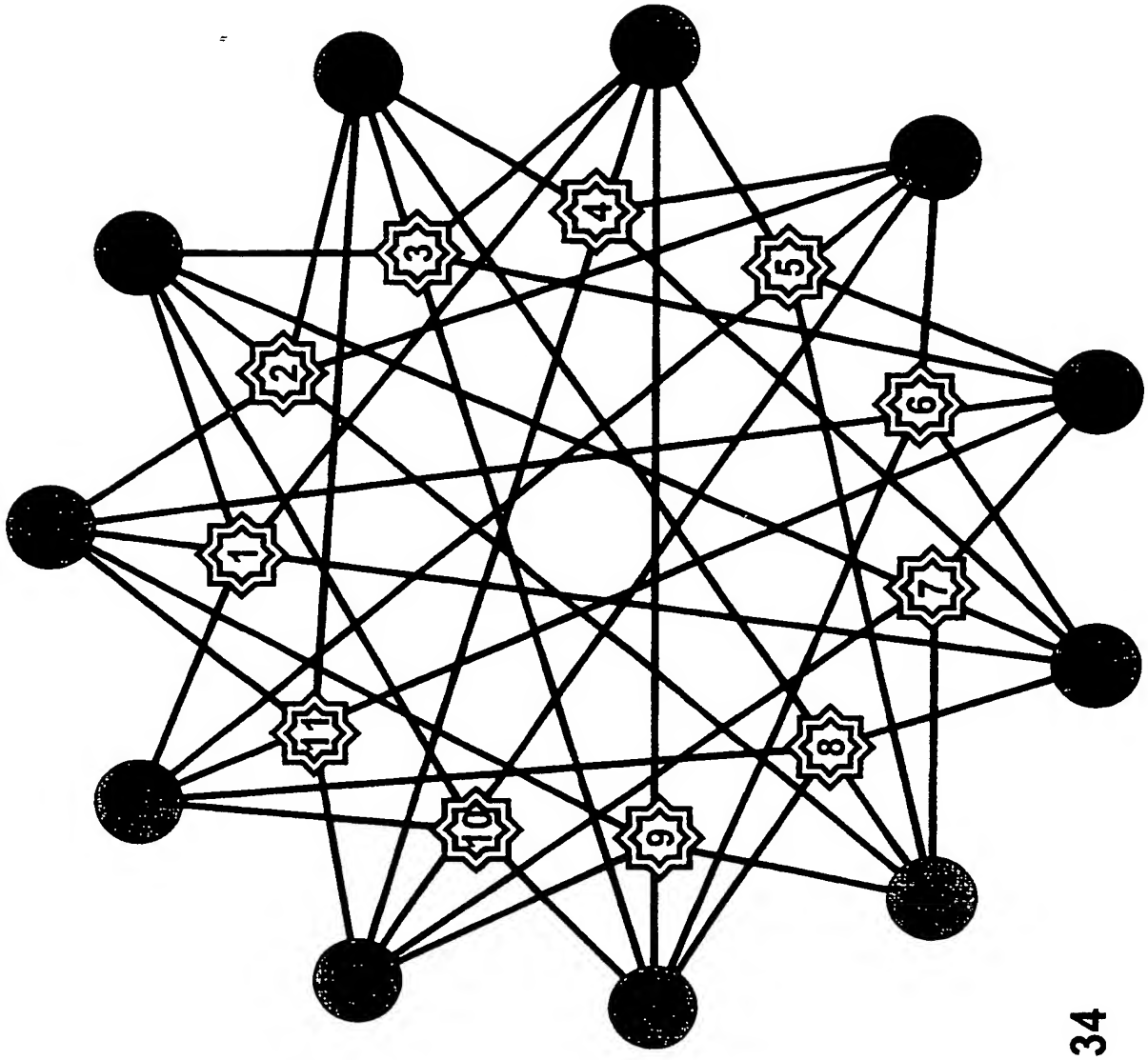


Figure 34

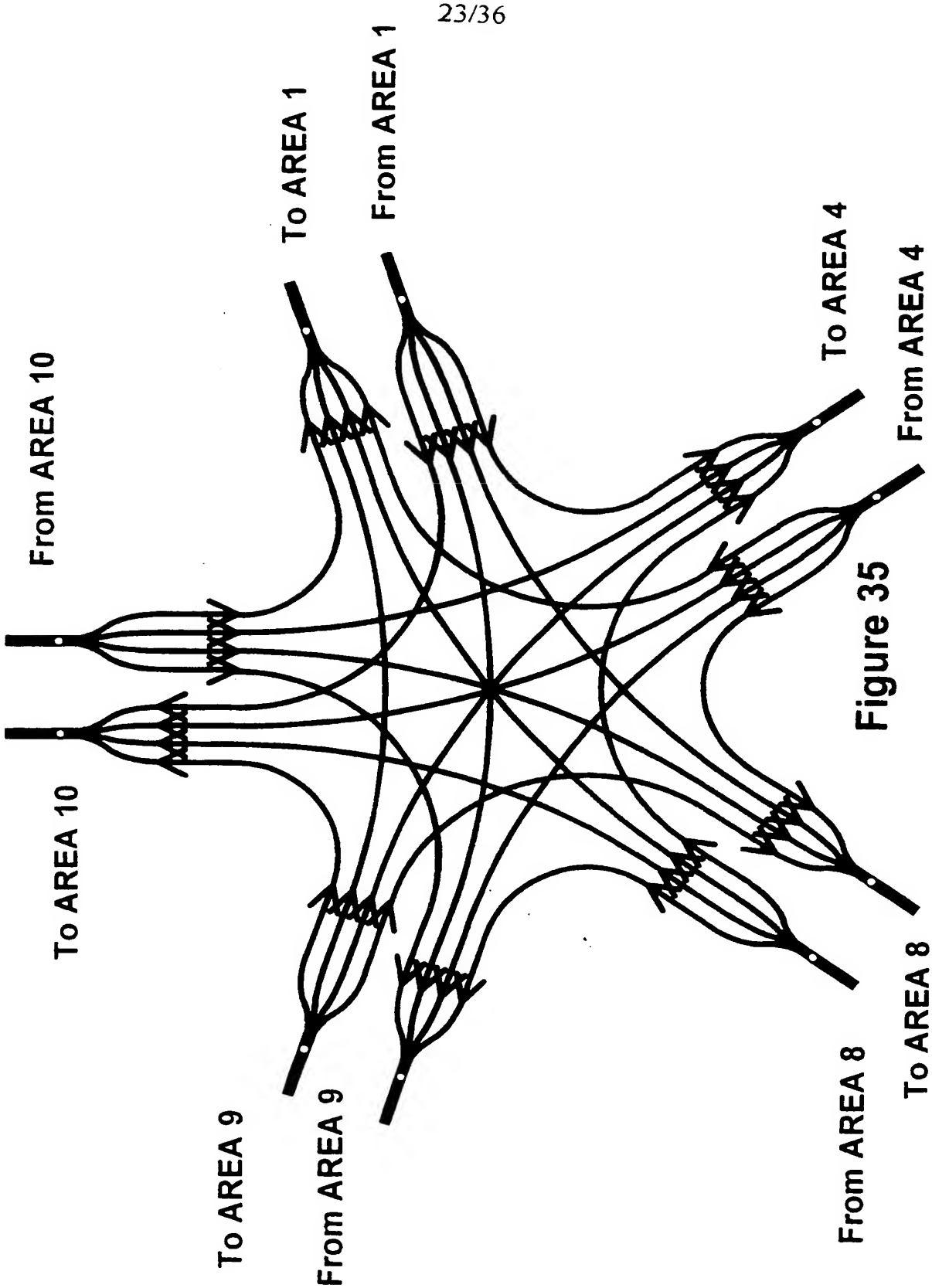

From AREA 10
To AREA 10
To AREA 1
From AREA 1
To AREA 4
From AREA 4
To AREA 9
From AREA 9
From AREA 8
To AREA 8

Figure 35

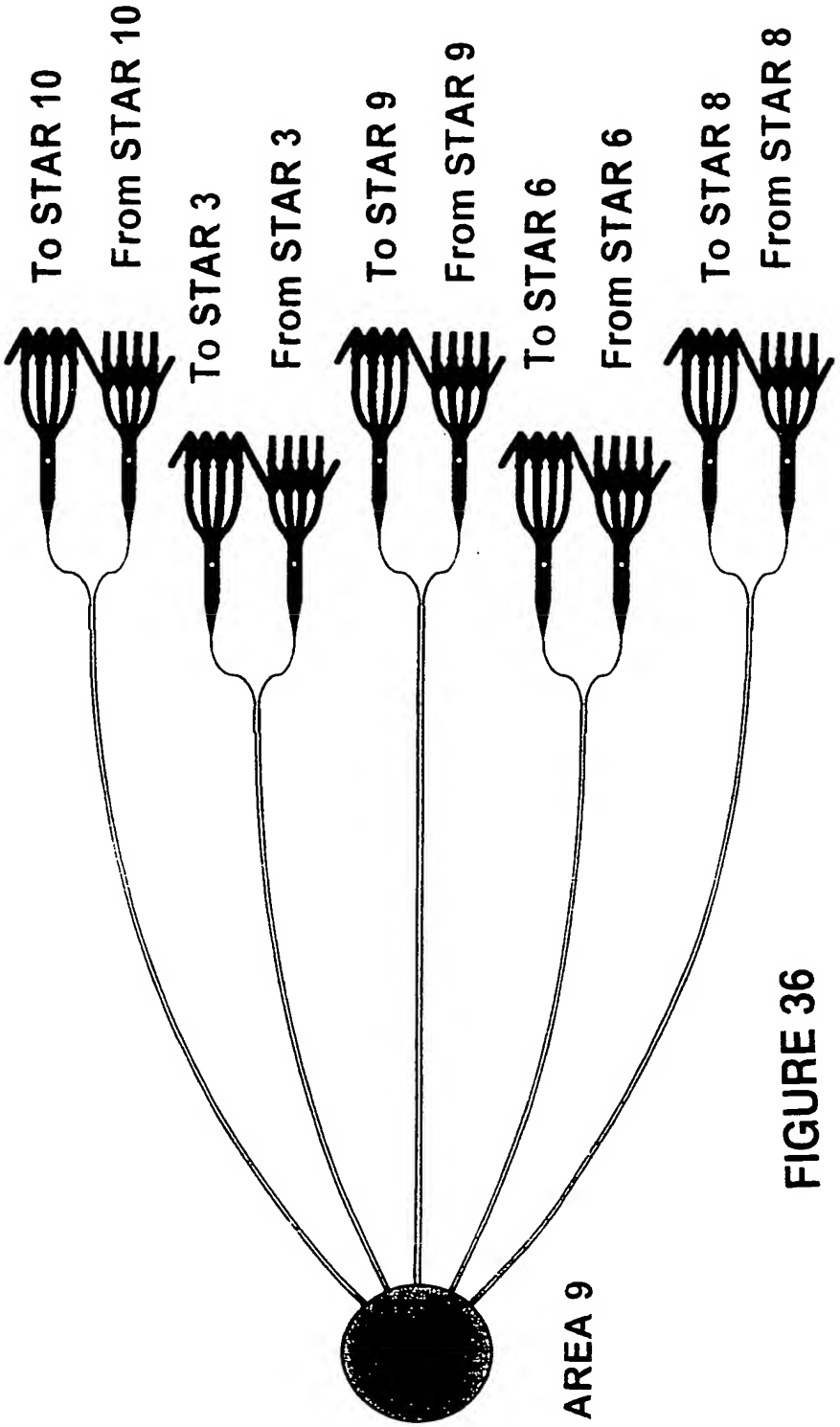

To STAR 10
From STAR 10
To STAR 3
From STAR 3
To STAR 9
From STAR 9
To STAR 6
From STAR 6
To STAR 8
From STAR 8
AREA 9

FIGURE 36

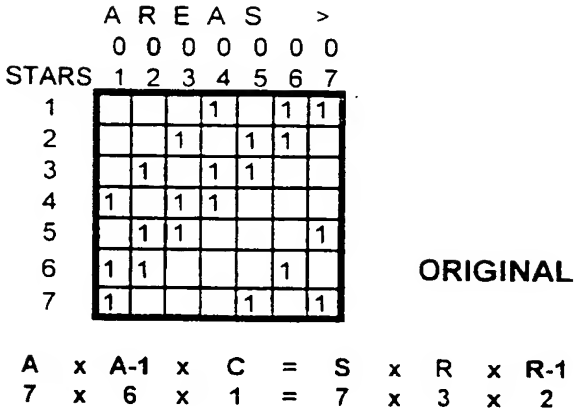


Figure 37

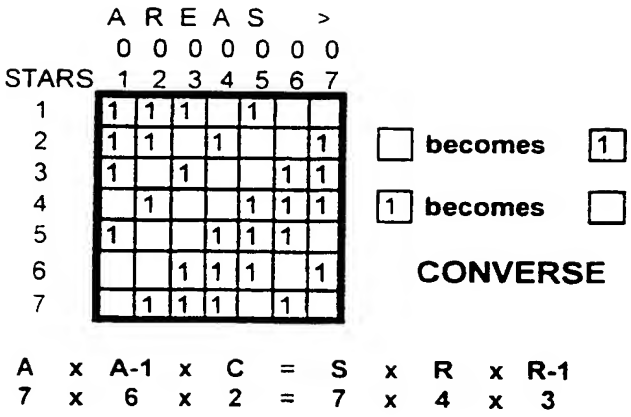


Figure 38

Figure 39

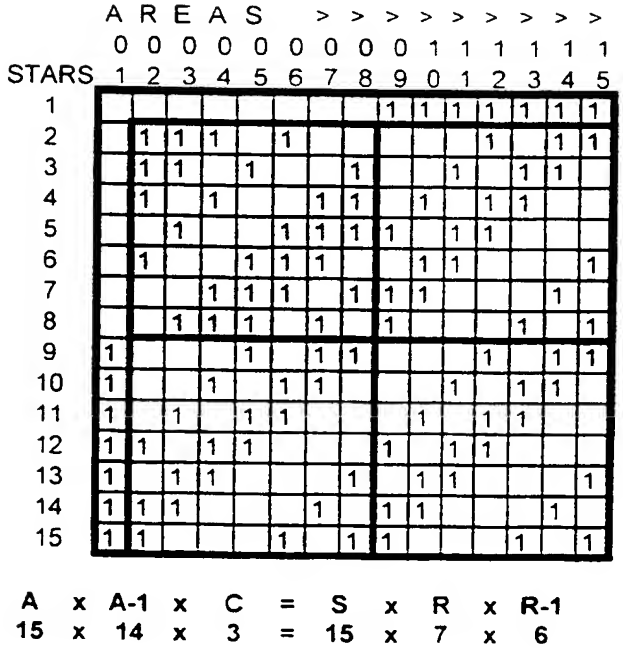


Figure 40

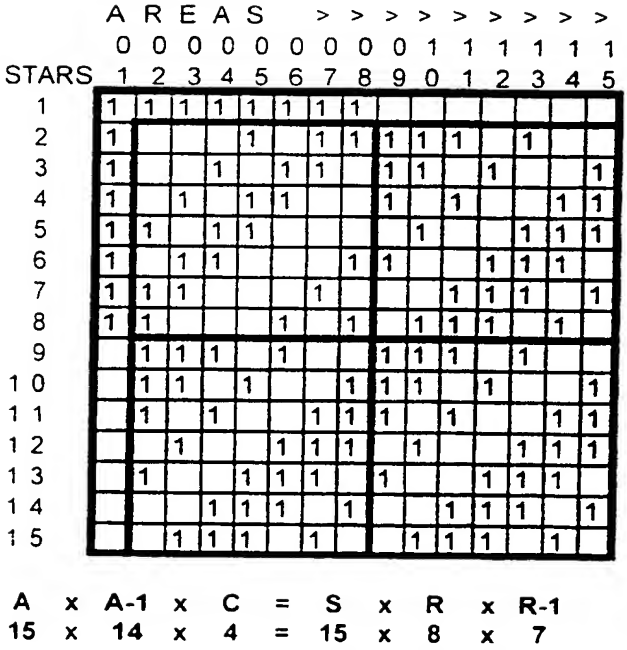
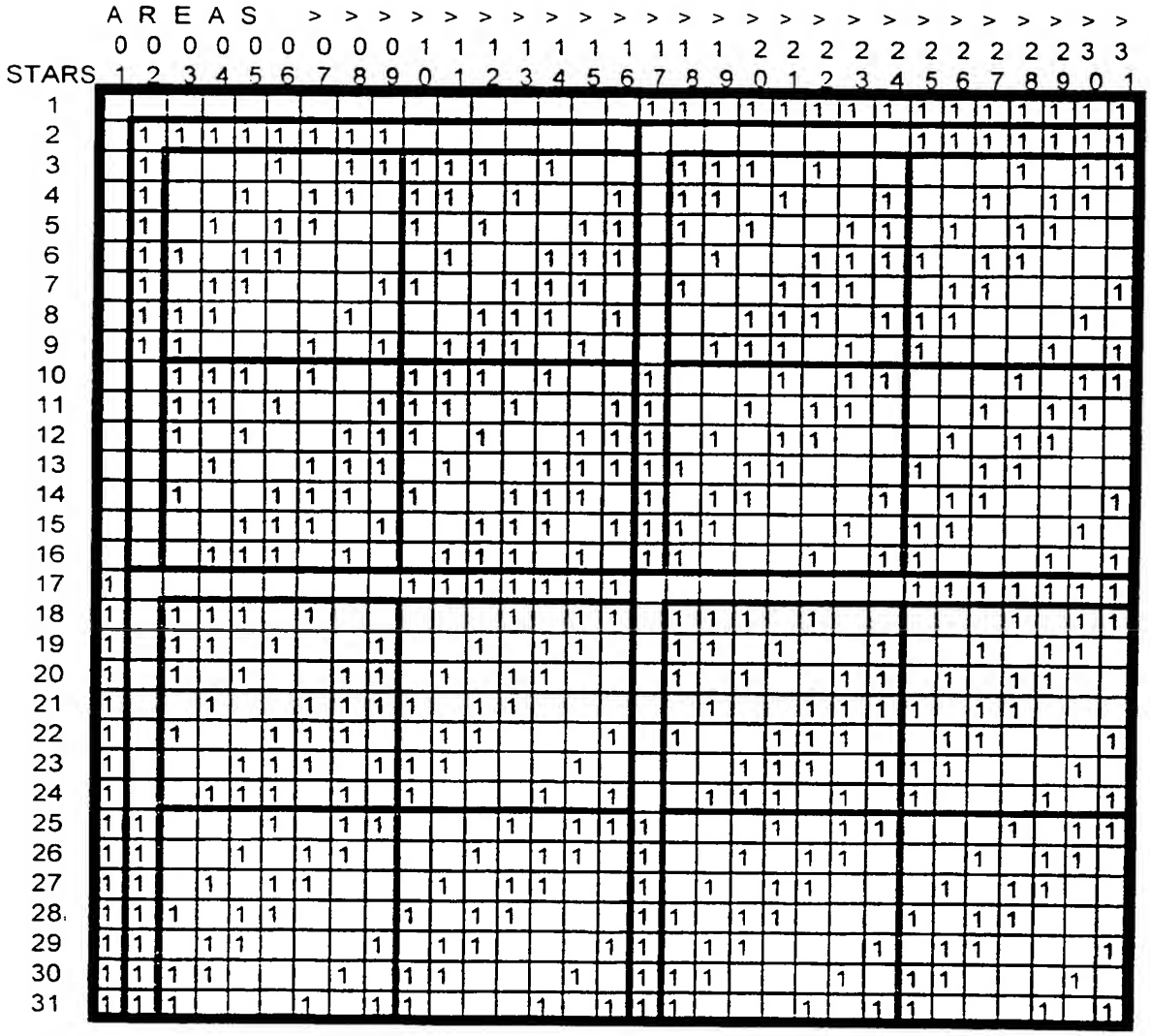


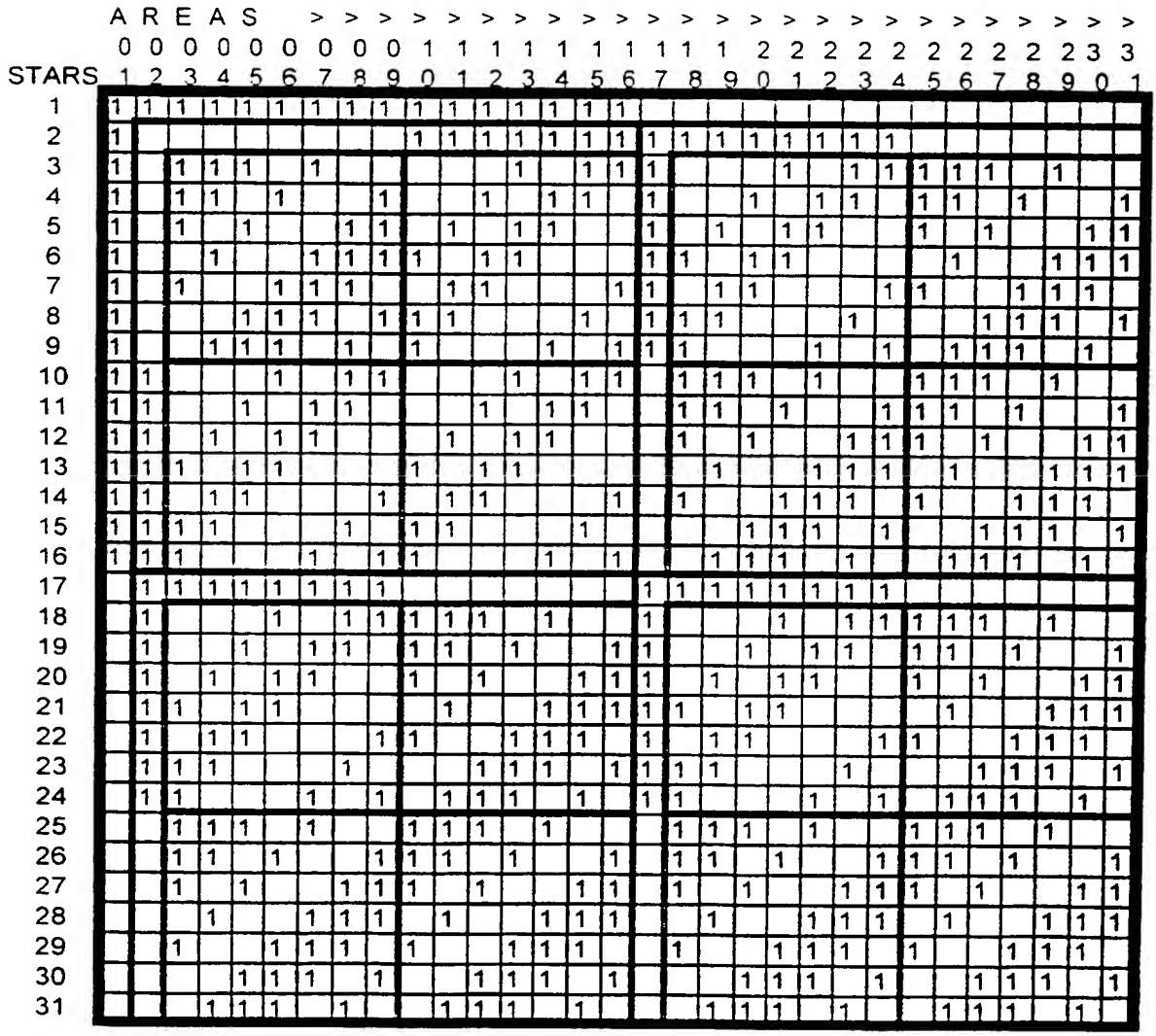
Figure 41



A x A-1 x C = S x R x R-1
31 x 30 x 7 = 31 x 15 x 14

ORIGINAL

Figure 42



A x A-1 x C = S x R x R-1
31 x 30 x 8 = 31 x 16 x 15

CONVERSE

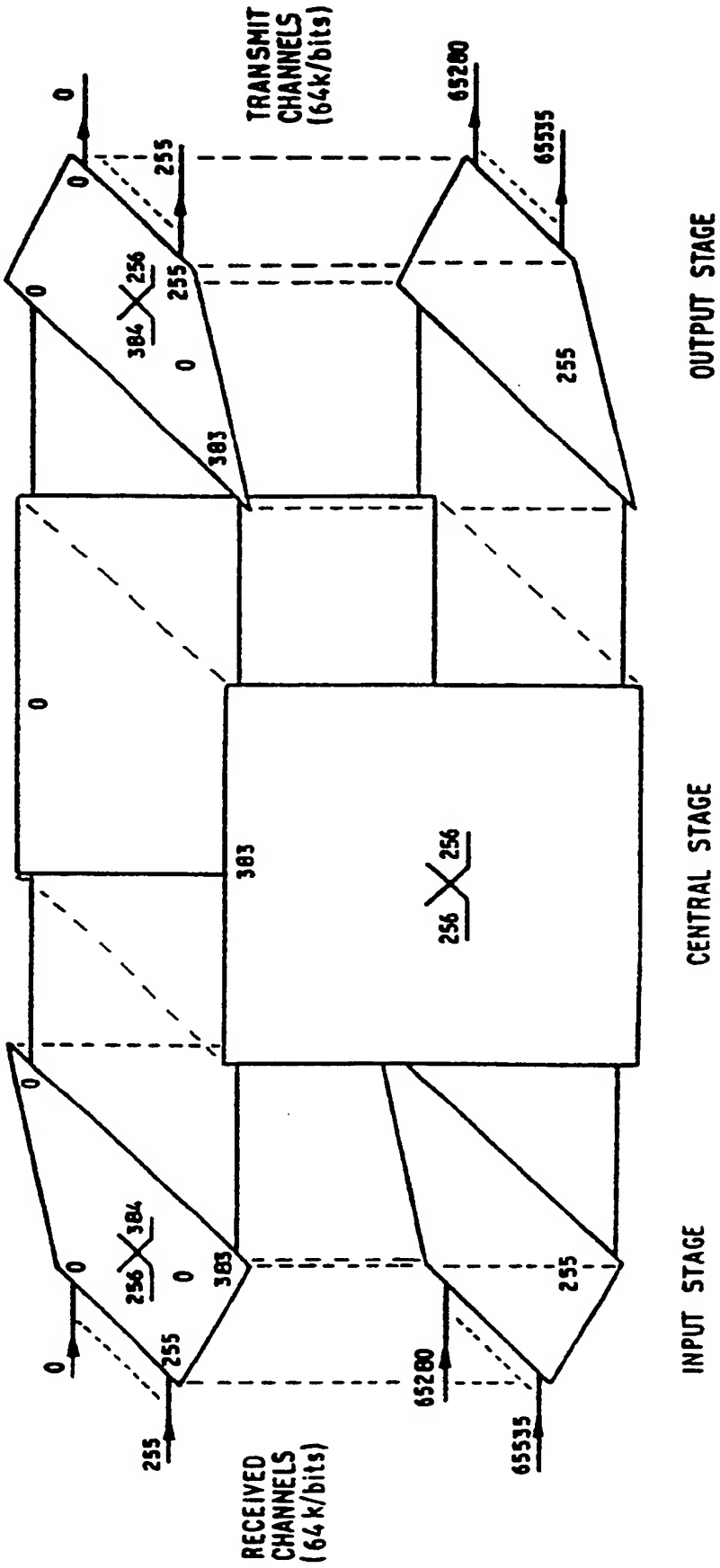

TRANSMIT CHANNELS (64k/bits)
0
255
65280
65535
OUTPUT STAGE
384
256
383
CENTRAL STAGE
INPUT STAGE
RECEIVED CHANNELS (64k/bits)

Figure 43

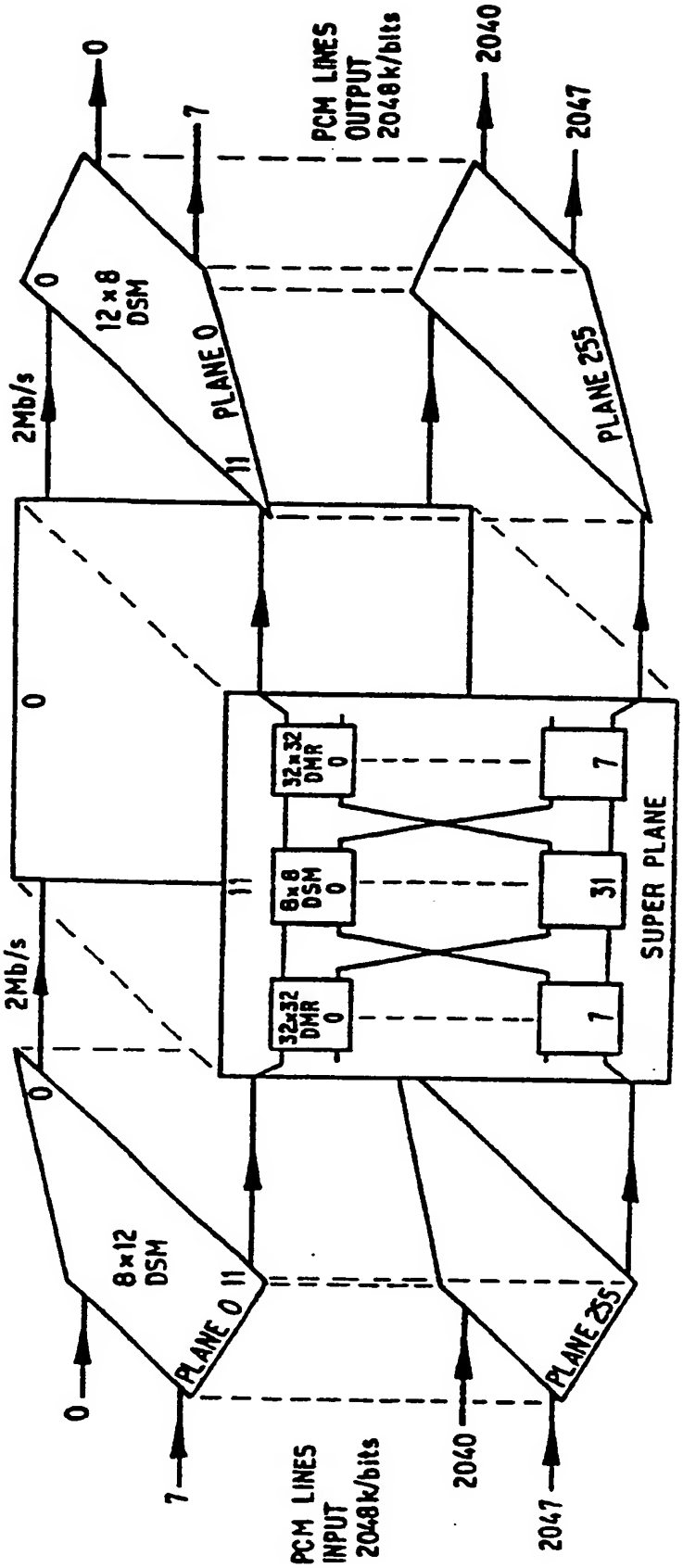

PCM LINES OUTPUT 2048k/bits
0
7
2040
2047
12x8 DSM
PLANE 0
PLANE 255
2Mb/s
11
0
32x32 DMR
8x8 DSM
SUPER PLANE
31
8x12 DSM
PCM LINES INPUT 2048k/bits

Figure 44

TIME SLOT	LINE NUMBER 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
0	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	>
1	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	
2	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	
3	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	
4	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	53	52	51	50	
5	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	53	
6	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	54	
7	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	55	
8	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	57	56	
9	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	61	60	59	58	
10	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	62	
11	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
12	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
13	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	
14	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	
15	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	
16	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	
17	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	
18	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	
19	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	
20	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
21	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	
22	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	
23	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	
24	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	
25	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	
26	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	
27	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	
28	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	
29	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	
30	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	
31	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	>

Figure 45A

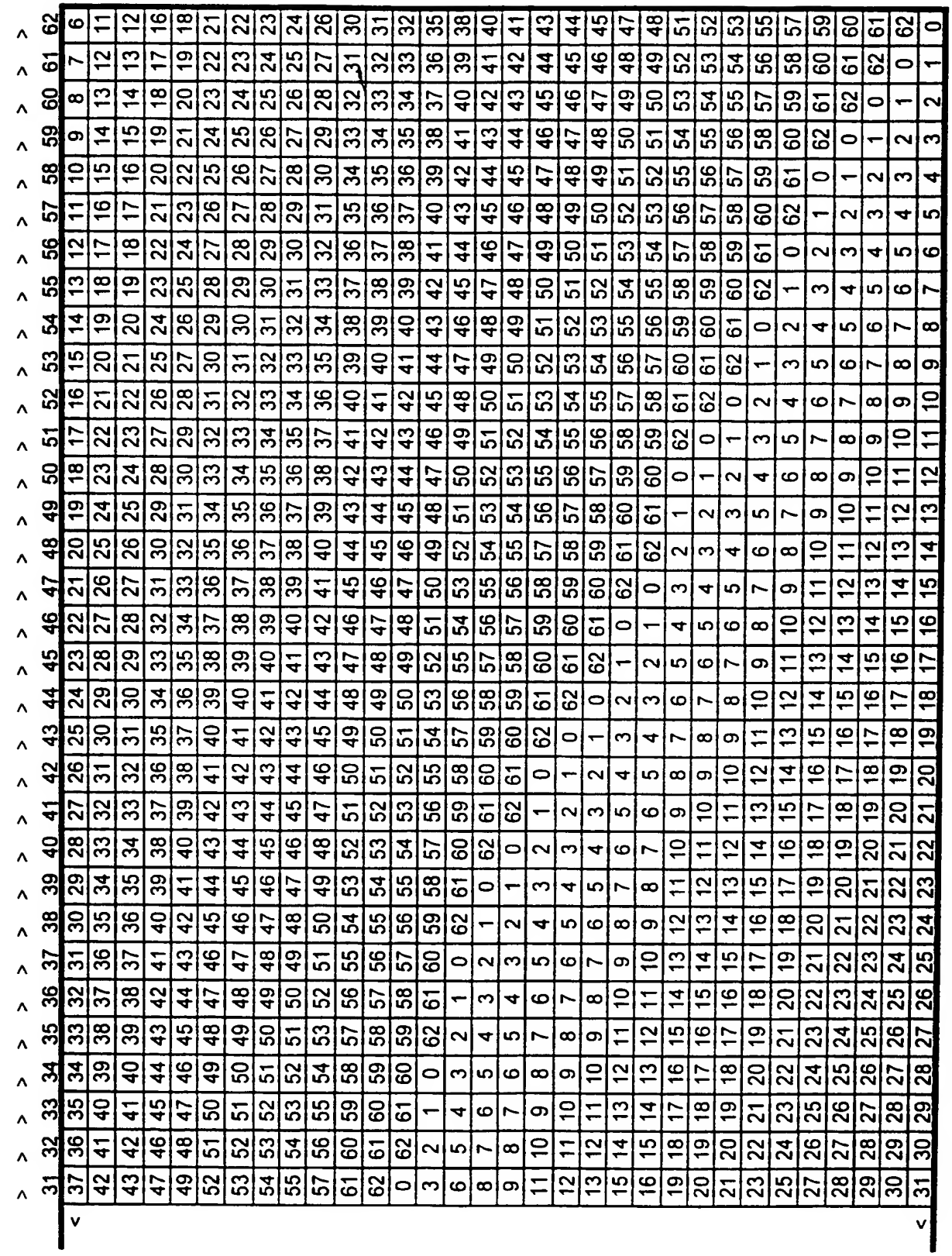


Figure 45B

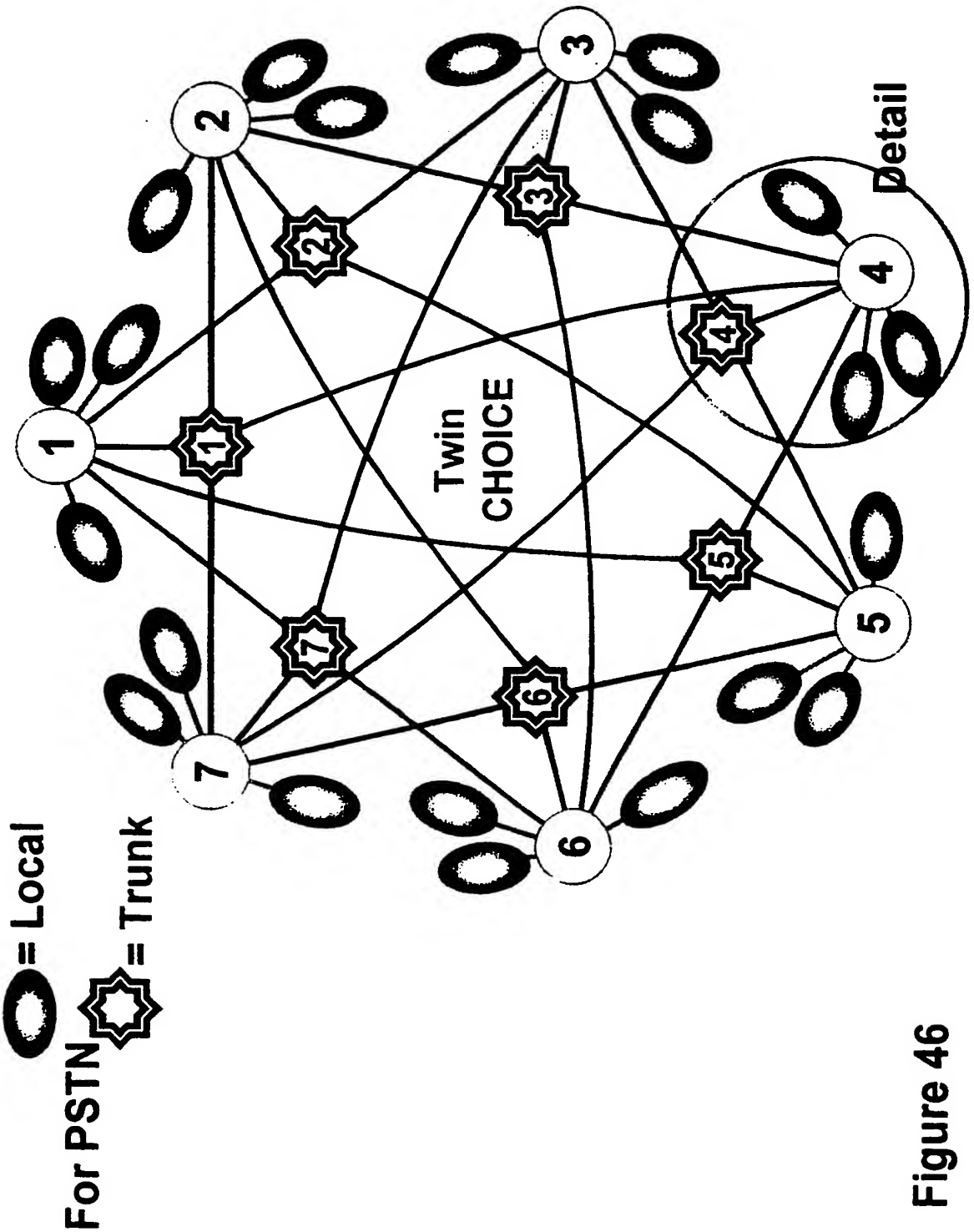


Figure 46

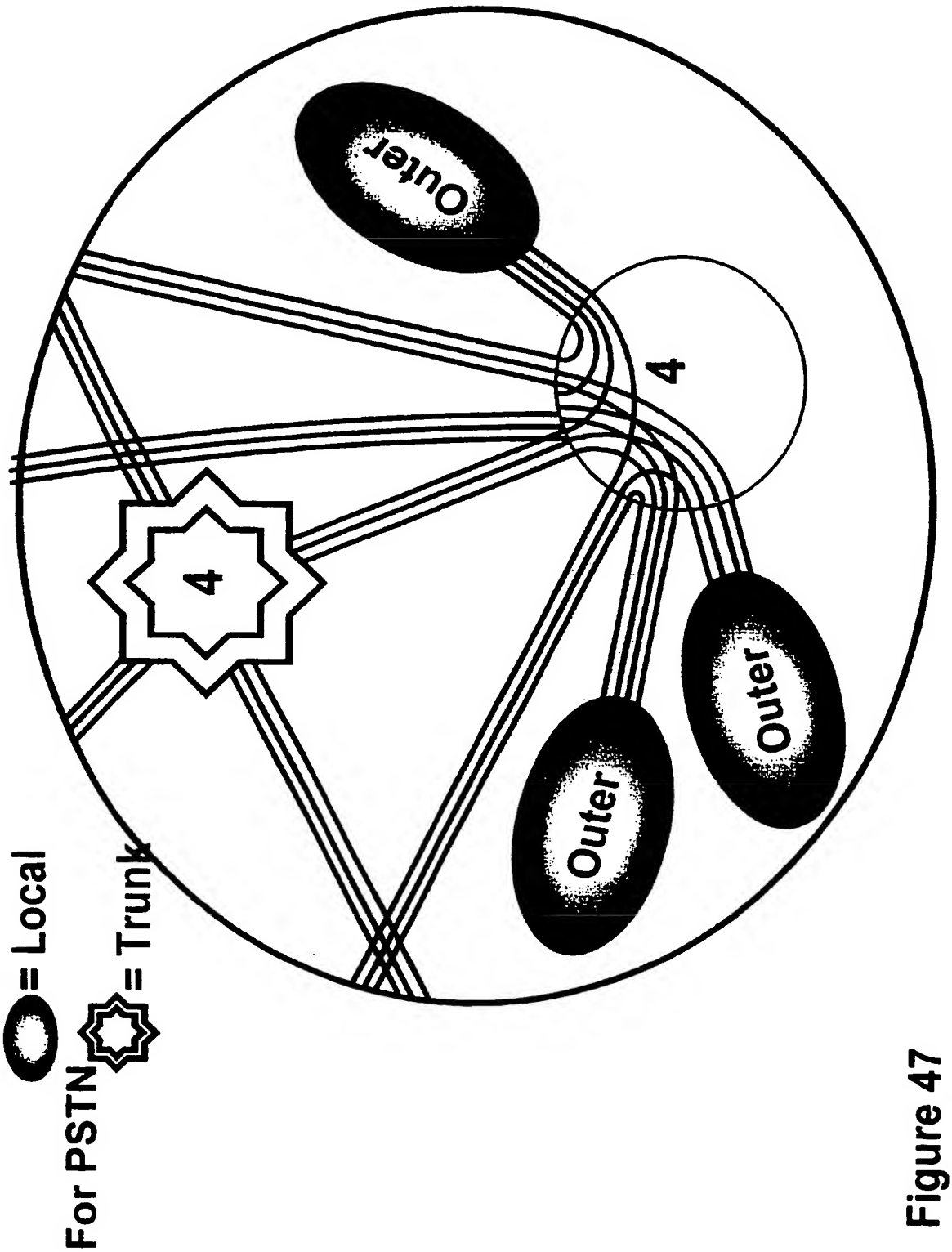


Figure 47

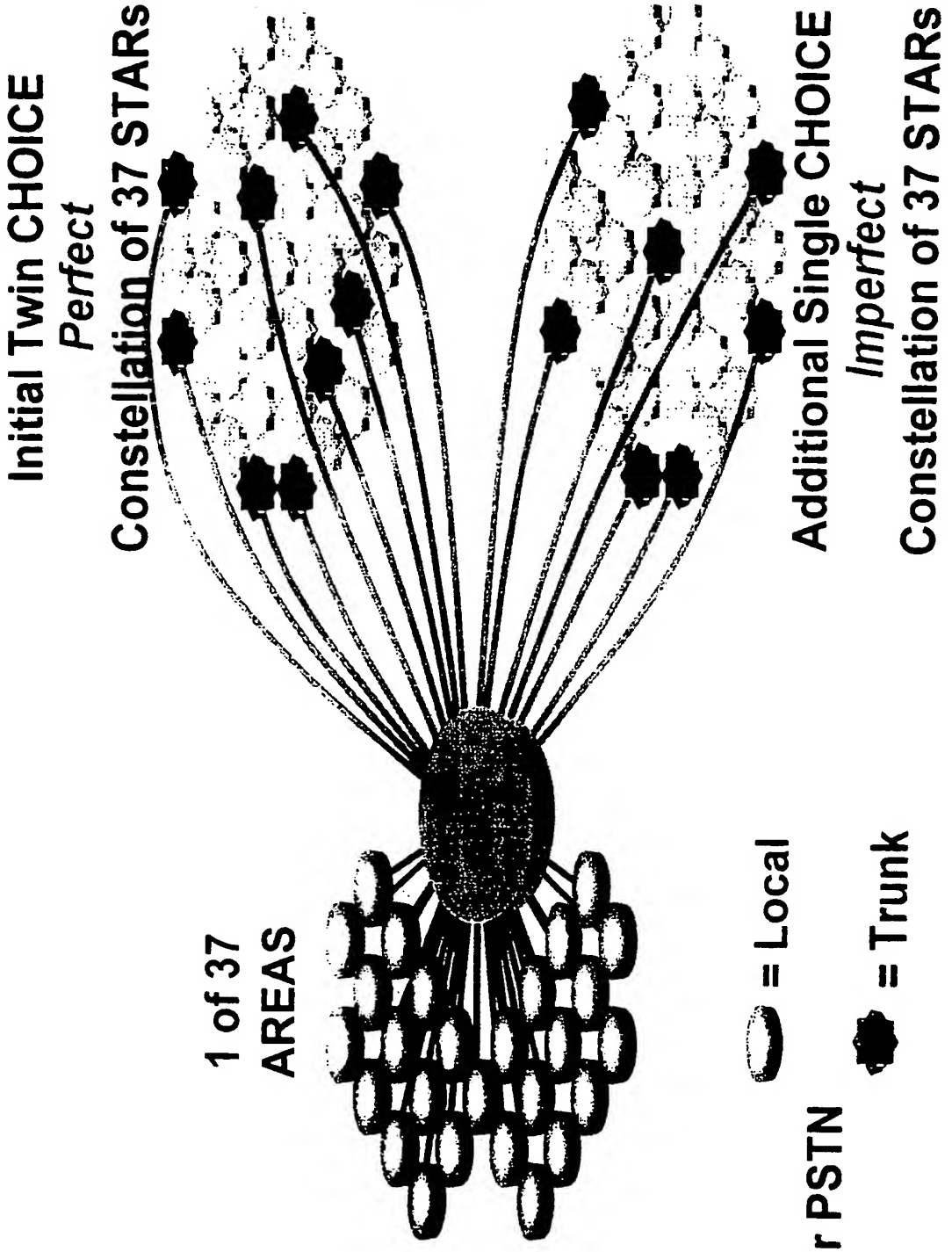

Initial Twin CHOICE
Perfect
Constellation of 37 STARs
Additional Single CHOICE
Imperfect
Constellation of 37 STARs
1 of 37
AREAS
= Local
= Trunk
For PSTN

Figure 48

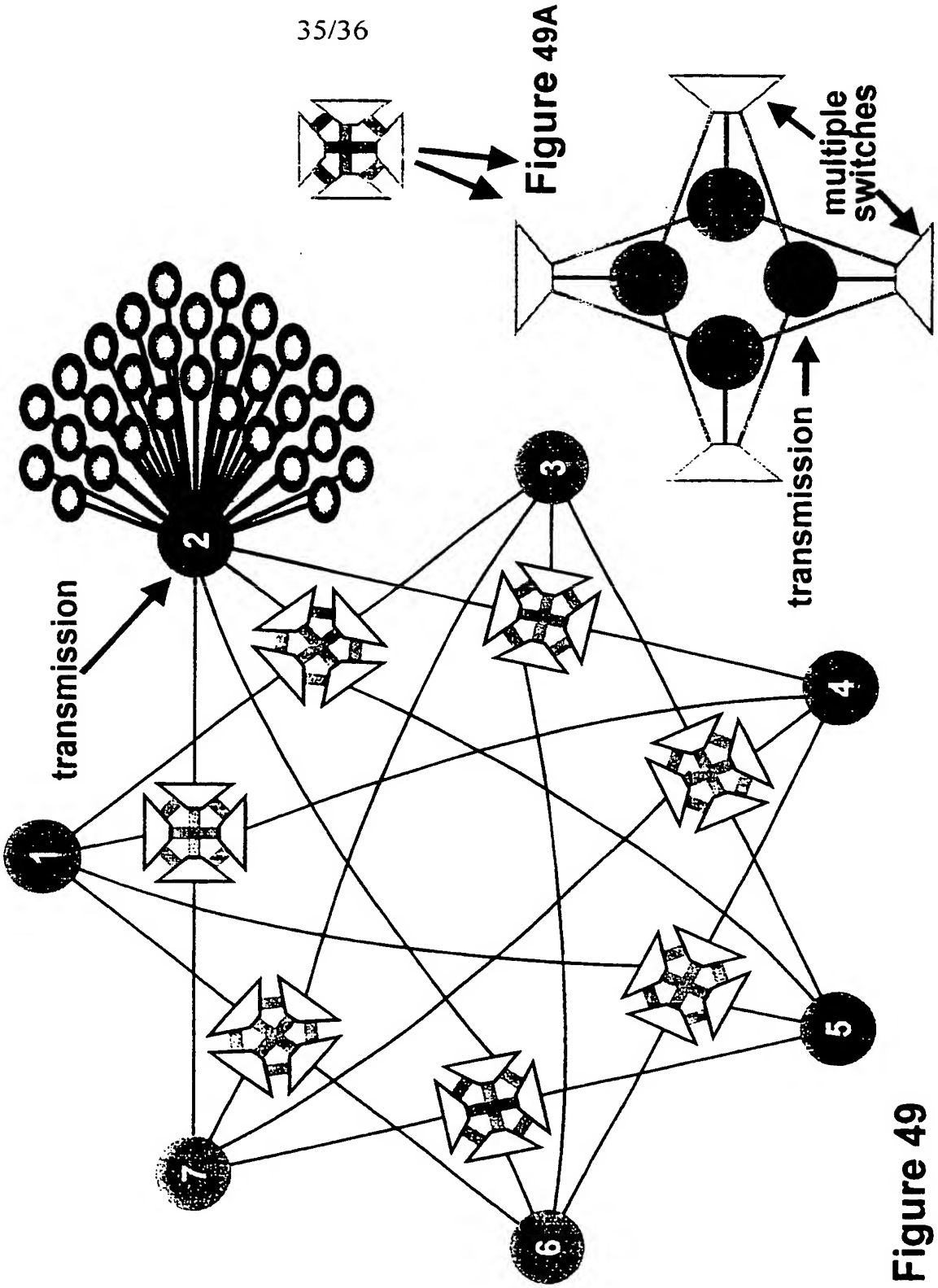


Figure 49A
multiple switches
transmission
transmission
1
2
3
4
5
6
7

Figure 49

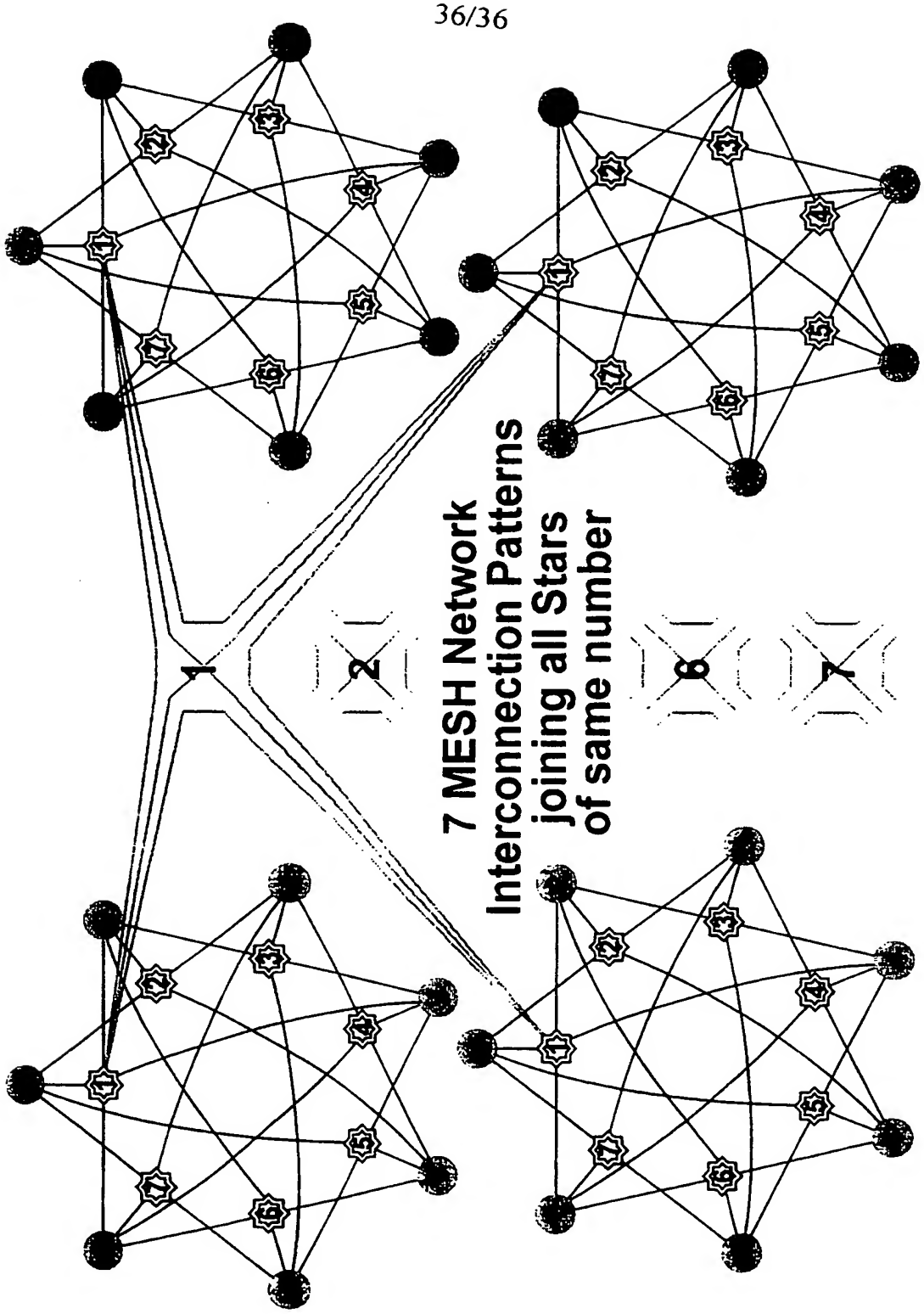

7 MESH Network
Interconnection Patterns
joining all Stars
of same number
1
2
6
7

Figure 50

INTERNATIONAL SEARCH REPORT

Intern. ial Application No
PCT/GB 00/01999

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KUNIO KAMIMURA ET AL: "AN EFFICIENT METHOD FOR DETERMINING ECONOMICAL CONFIGURATIONS OF ELEMENTARY PACKET-SWITCHED NETWORKS" IEEE TRANSACTIONS ON COMMUNICATIONS,US,IEEE INC. NEW YORK, vol. 39, no. 2, 1 February 1991 (1991-02-01), pages 278-288, XP000225306 ISSN: 0090-6778 abstract page 278, right-hand column, line 13 - line 46; figure 1 page 279, right-hand column, line 1 - line 41; figure 2	1,2,4-6, 8,26,27
Y		7,17,18, 21,28
A		3,9,15, 16,22-25

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 September 2000	22/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Brichau, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Interna ial Application No
PCT/GB 00/01999

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	GERLA M ET AL: "PROTOCOLS FOR AN OPTICAL STAR INTERCONNECT FOR HIGH SPEED MESH NETWORKS" PROCEEDINGS OF INFOCOM,US,LOS ALAMITOS, IEEE COMP. SOC. PRESS, vol. CONF. 14, 2 April 1995 (1995-04-02), pages 146-153, XP000580574 ISBN: 0-7803-2524-9 page 146, left-hand column, line 1 -right-hand column, line 11; figure 1 page 148, left-hand column, line 28 -page 149, left-hand column, line 18; figure 3	17,18,21
A		20
Y	GB 2 258 582 A (PLESSEY TELECOMM) 10 February 1993 (1993-02-10) page 3, line 1 - line 15 page 10, line 1 -page 11, line 30 page 15, line 4 -page 16, line 35 page 21, line 26 -page 29, line 9	7,28

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. ial Application No
PCT/GB 00/01999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2258582 A	10-02-1993	DE 69226013 D	30-07-1998
		DE 69226013 T	29-10-1998
		EP 0555429 A	18-08-1993
		ES 2117671 T	16-08-1998
		WO 9303565 A	18-02-1993
		JP 6501829 T	24-02-1994
		US 5703879 A	30-12-1997